STUDIES IN ENTOMOGENOUS FUNGI.

With Plates III—V*.

I. THE NECTRIAE PARASITIC ON SCALE INSECTS.

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Among the fungi known to develop on scale insects, the *Nectriae* occupy the first place from the historical point of view, a conidial stage belonging to this group having been described as growing on a coccus in 1848; while during recent years they have become the species most generally employed in the numerous attempts to control scale insects by means of entomogenous fungi. The present account deals with them from the systematic standpoint, and is the outcome of an examination of a number of collections from different countries which have come into my possession during the last fifteen years, as well as of the specimens in the Herbaria of the Royal Botanic Gardens, Kew, and the British Museum (Natural History).

My thanks are due to Mr E. E. Green, the well-known authority on Coccidae, for much of the available material from Ceylon and elsewhere, including part of the specimens examined and described by Parkin; to Mr H. S. Fawcett for material from Florida; Mr F. W. South, for specimens from the West Indies; Dr E. J. Butler, for specimens from India; Mr C. C. Brittlebank, for specimens from Australia; Prof. Ito, for specimens from Japan and Formosa; and Dr C. Spegazzini for specimens from South America.

I must also offer my apologies to the gentlemen named for the delay in dealing with the specimens they had so readily contributed.

Historical.

The earliest record of any fungus of this group on a coccid was made by Desmazières in 1848. Specimens of a conidial fungus, which appeared on scale insects on willows and ash trees in the winter months at Caen (Cadonum), France, had been sent him by one of his correspondents, M. Roberge, and for these he instituted a new genus, *Microcera*, with the species *Microcera coccophila*.

Desmazières' generic description is "*Microcera* Desmaz., nov. gen. Velum externum persistens, membranaceo-floccosum, dein supra in lacinias plures rumpens; receptaculum clavatum, carnosum, e fibris subsimplicibus sporidiiferis formatum; sporidia fusiformia, arcuata."

* The Plates will accompany the continuation of this article in the next Part of the Transactions.

The specific description is "*Microcera coccophila* Desmaz. Minutissima, subcaespitosa, cornuto-conica, simplex, lateritio-rosea, basi membrana tenuissima albida vaginato-connata. Sporidiis paucis hyalinis, elongatis, utrinque acutis. Hab., in Coccis, Hieme."

Desmazières was so struck by the singular formation and habitat of the fungus that he gave a further extended account of it. In this he was somewhat unfortunate, as it is chiefly this amplification which has led to doubt concerning the identity of his species, and to the inclusion in his genus of forms which have only little relation to it. The following details are taken from his account.

The fungus occurs at the margin of the scale. It appears first as a small horn, sometimes cylindric and obtuse, but most often attenuated from the base to a pointed apex. Each scale produces from one to three horns, but it is not rare to find scales from which arise five or six horns, apparently almost recumbent on the stem of the plant and forming a sort of star. The horns arise from a narrow stroma which runs beneath the margin of the scale, and the growth of this stroma inwards towards the centre ultimately forces off the scale and forms a tubercular mass which unites the bases of the horns. The horns are divergent, and scarcely half a millimetre high. Each is at first enveloped in a white sheath, very thin and membranous, which makes it appear flesh-coloured. This sheath is soon pierced at the apex, and the horn emerges in the form of a small cone, of a dark rose colour, generally with an acute apex which is sometimes curved into a hook. In that state, the persistent sheath, at the base of the little fungus, forms, as it were, a closely adherent volva, the margin of which is fringed. The horn appears fleshy, but is composed, like the sheath, entirely of hyaline filaments, almost simple, obscurely septate, very long, and scarcely 2·5 μ broad. The spores occur among these filaments, few in number, but large, hyaline, fusiform, pointed, and arcuate. The longest are about 100 μ long, with a breadth scarcely double that of the filaments. Frequently, several globules, somewhat equally spaced, occupy the central part of the spore, but septa have not been clearly distinguished.

Desmazières summarised as follows: "In the presence of a velum or volva, this minute production has, to some extent, the nature of a phalloid; in its habitat and fibrillose structure it bears some resemblance to the entomogenous Isarias provided with superficial basidia; and, finally, by its texture, its fibrils or filaments, and the shape of its spores, it is allied to the *Tuberculariaceae*, near *Fusarium*, and to the genus *Ditiola* which is provided with a membranous, evanescent covering or velum."

Desmazières' fungus was next described by the Tulasnes, in

Selecta Fungorum Carpologia, vol. I, p. 130, and vol. III, p. 105. They examined Desmazières' specimens, Plantae Crypt. Gallicae, ed. altera, fasc. XXVII, Nos. 1350 and 1750, and, in the approved modern fashion, had obtained specimens from the type locality. With these they correlated specimens from Florence, on *Laurus nobilis*, which exhibited both the conidial and the perithecial stages. The latter had been issued by Rabenhorst in Herbarium Mycologicum (Ser. nova, t. III (1860), Nos. 262 and 269) as *Nectria episphaeria* Tode and *Microcera coccophila* Desm. respectively. The type locality for the perithecial fungus is therefore Florence, not France as usually stated.

The Tulasnes' description may be summarised as follows. The fungus produces beneath the scale a pallid, or pale rose, fleshy stroma, paler and sparingly byssoid at the edge, which emerges and forms a narrow unequal margin round it. From this there arises a simple, thick, obtuse clava, about a line high. There is usually only one clava, rarely several. The apex is more deeply coloured, red, and bears, in a compact mass, curved linear-lanceolate conidia, 65 × 6·5 μ, three to five septate, borne singly on slender conidiophores. The perithecia appear later, at the base of the clava, or on the margin of the stroma, the clavae being wanting or aborted; they are small, globose, obtusely and very shortly papillate, sessile, very smooth, shining red, fleshy and fragile, in groups of three to five, somewhat collapsed when old. The asci are linear-cylindric, 60–80 × 6·5 μ, obtuse, subsessile, eight-spored, thin-walled; paraphyses are lacking (paraphyses vulgo quasi omnino desiderantur); the spores are smooth, muticate, subhyaline, often obliquely monostichous, ovate, straight, 10 × 5 μ, equally medially septate, and somewhat constricted.

It was noted that in Roberge's specimens from Caen several clavae might arise from the edge of the same scale, but in the specimens from Florence the conidial stage was much rarer.

The Tulasnes placed the fungus in their genus *Sphaerostilbe*, as it had a *Nectria* perithecial stage and a Stilboid conidial form. They stated that the Roberge specimens exhibited clavae which exactly resembled the true *Stilbum* of Tode, and added that the clava of *Microcera* imitated exactly *Stilbum flammeum* Berk. (*Atractium flammeum* Berk. and Rav.), in its form and the slenderness of its filaments, which were united by short isthmuses (ladder connections) and separated into a few straight branches. In their earlier note, they say that *Microcera* differs little from *Atractium*.

For the Tulasnes, then, *Microcera* was a *Stilbum* with long curved *Fusarium* spores. They were somewhat scornful of Desmazières' velum and his comparison with the phalloids,

stating that, whatever appearance of a veil there was, was due to a covering of white adpressed mycelium over the basal stroma, and no true volva was present. This immediately suggests a doubt whether they were dealing with the same fungus, for *Microcera* has the structure described by Desmazières, by whatever name one may call it.

There can, however, be no doubt that the *Microcera* of Desmazières is the *Sphaerostilbe* (conidial stage) of the Tulasnes. Yet one is loth to believe that such acute observers could have overlooked a feature which had been so strongly emphasised in a previous description. The probable explanation is that they were misled by Desmazières' unhappy comparison to a phalloid, and sought for a velum, or volva, surrounding the base of the stem of the Stilboid form: this supposition would appear to be supported by their statement that the apparent volva is merely mycelium on the surface of the stroma. But Desmazières' "velum" consists of the outer layer of the erect parallel hyphae which form the synnema; these are adherent to, or form the outer layer of, the stalk, but they do not terminate above in conidiophores, but in a series of teeth just below the head. They constitute a closely adherent sheath divided above into several narrow teeth which sometimes separate into a fringe of hyphae.

The next record of a *Nectria* on scale insects was made by Berkeley and Broome in their Fungi of Ceylon, No. 1028 (1873). They described there a species, as "*Nectria aurantiicola* B. and Br. Peritheciis aurantiacis in stromate erecto sitis; ascis clavatis; sporidiis ellipticis uniseptatis, sporisque fusuloideis (Thwaites, 190). On orange twigs. Ascospores 15 μ long, 7·5 μ wide; conidia fusiform, curved, multiseptate, 90 μ long; others triseptate and strongly curved, 20 μ long. Apparently growing from some Coccus." They gave figures of "a barren plant"; a stilboid synnema, bearing perithecia on the stalk; asci and ascospores; "flocci with fusiform conidia"; and a single long conidium. In 1875, Berkeley and Curtis described *Nectria aglaothele*, which grew on the remains of a coccus on alder in New England.

About 1886, Spegazzini described a new species of *Nectria*, growing on a coccus on fallen leaves, from Brazil, as *Nectria coccorum*; and a few years later (1889), another species, on a coccus on living leaves of a *Eugenia*, from the same country, as *Nectria coccogena*. No conidial stage was recorded for either.

In 1886, Ellis and Everhart described *Ophionectria coccicola* from Florida.

The number of conidial forms was increased in 1887 by the description of *Microcera rectispora* Cke. and Mass. This had

been sent by Bailey from Brisbane, Queensland. In the Handbook of Australian Fungi, Cooke gave figures of the conidia. It grew on "Coccus of the orange."

In 1892, Cooke enumerated and briefly described some of the foregoing species in his Vegetable Wasps and Plant Worms. Of *Microcera rectispora* Cke. and Mass., he stated, "In appearance it differs so little from the European species that, apart from the fructification (*sic*), they would be regarded as the same. So much importance has of late years been given to minute differences in spores that new species have become inevitable. In this instance, the spores are quite straight and spindle-shaped, acute at both ends, with about seven septa, and 150–200 × 10 μ." Cooke's figures suggest the conidial stage of *Ophionectria coccicola*.

In the same year, Ellis and Everhart published their North American Pyrenomycetes. In it they included *Sphaerostilbe coccophila* Tul., stating that specimens had been found on *Alnus serrulata* in Pennsylvania. Their description is practically that of Tulasne. They added "the conidial stage (*Microcera coccophila* Desm.) which has been sent from Florida by Dr Martin, and collected in Carolina by Ravenel (F. Am. 286) has stroma arising from various species of bark lice.. It is red, obtuse, and about 2 mm. high. The conidia are linear-lanceolate, 5–7 septate, and 56–65 × 5–6 μ, nearly hyaline."

In 1897, Rolfs reported *Sphaerostilbe coccophila* as a parasite of the San José Scale, *Aspidiotus perniciosus*, in Florida, and inaugurated the use of the fungus as a means of combating that pest. From Rolf's figures, it would appear that he had *Sphaerostilbe coccophila*, or a species closely allied, though later workers in Florida have undoubtedly confused two totally distinct forms.

McAlpine, in 1899, included descriptions of *Microcera rectispora* Cke. and Mass. and *Microcera coccophila* Desm. in his Fungus diseases of Citrus trees in Australia. His description of the former is that of Cooke and Massee. There does not appear to have been any but the type collection of this species; McAlpine cites Bailey's gathering, and adds that it was on *Chionaspis citri*. In the same publication, McAlpine described *Fusarium epicoccum*, on Red Scale on Mandarin orange.

In 1901, Nomura published a paper on the Scarlet fungus disease of Scale insects in Japan. As this was written in Japanese, it had been overlooked by later writers until Miyabe and Sawada drew attention to it. Nomura stated that the sporodochia of his species were not stilboid, but irregularly-shaped protuberances of the *Tuberculariа* type; and, after comparison with the figures of *Sphaerostilbe coccophila* given by

Rolfs, he came to the conclusion that his species was identical with that from Florida, but that both were distinct from *Sphaerostilbe coccophila* Tul. He named his species *Nectria coccophila*, and gave the dimensions of the ascospores as 15–20 × 5–6 μ. It occurred on *Aspidiotus perniciosus* and *Diaspis pentagona*.

In the same year, Zimmermann published an account of the fungi parasitic on scale insects in Java. He described a *Nectria* with a stilboid synnema, which he named *Nectria coccidophthora*, distinguishing it from *Nectria aurantiicola* B. and Br. by its colour and the form of the synnemata. It occurred on *Mytilaspis* sp. and *Parlatoria zizyphi*. In addition, Zimmermann recorded and figured *Ophionectria coccicola*, and described two other new species, *Lisea Parlatoriae* on *Parlatoria zizyphi*, and *Broomella Ichnaspidis* on *Ichnaspis filiformis*.

In 1902, Hennings instituted a new genus *Tetracrium* for a conidial fungus found in company with scale insects on orange leaves, in Brazil, the species being named *Tetracrium Aurantii*. This specimen was re-examined by von Höhnel in 1911, and found to be identical in structure with the conidial stage of *Ophionectria coccicola*. Von Höhnel also found on the type specimen perithecia which he regarded as belonging to the genus *Puttemansia* Henn.; he named these *Puttemansia Aurantii*, and made corresponding alterations in the nomenclature of the North American species.

In 1903 Hennings described a new species of *Fusarium*, *Fusarium coccidicola*, on a coccid on tea in German East Africa.

In 1904, McAlpine added two new species of *Microcera*, *Microcera tasmaniensis* on *Aspidiotus* on *Eucalyptus*, and *Microcera Mytilaspis* on a scale on *Hymenanthera dentata*, and gave figures of both species.

Parkin, in 1906, published a general account of the fungi parasitic on scale insects, and gave descriptions of a number of forms, collected in Ceylon and elsewhere. He referred the Ceylon Nectrias to *Nectria coccidophthora*, although there was a previous Ceylon record, viz. that of *Nectria aurantiicola*. The chief merit of his paper, as far as the present group is concerned, is that he recognised that there are two quite different conidial forms, appertaining to the *Nectriae*, common on scale insects in the tropics. But he assigned the *Microcera* form to *Fusarium*, and the other to *Microcera*. Parkin also refers to a *Calonectria*, found on *Chionaspis vitis* and *Mytilaspis citricola* in Ceylon.

In 1907, Trabut described *Microcera Parlatoriae*, found on *Parlatoria zizyphi* on orange at Algiers.

In 1908, Fawcett summarised the records of "*Sphaerostilbe coccophila*," and gave details of its structure, in a paper en-

titled "Fungi parasitic on *Aleyrodes Citri*." He also described a new species of "*Microcera*," but did not name it.

In 1909, Saccardo added a new European species of *Microcera*, *M. curta*, from Germany; and, in 1912, Patouillard described *Microcera Tonduzii* from Costa Rica.

Miyabe and Sawada gave an account of the fungi parasitic on scale insects in Formosa in 1913. They referred the common Japanese species to *Sphaerostilbe coccophila*, with considerable doubt. A *Microcera* which belongs to Parkin's second group was named *Microcera Fujikuroi*. *Ophionectria coccicola* was recorded, and a new species, *Ophionectria tetraspora*, was described.

Sawada subsequently (1914) published, in Japanese, a paper on "Some Remarkable Parasitic Fungi on Insects found in Japan." The only species mentioned which is relevant to the present subject is a new species of *Fusarium*, *Fusarium Aspidioti*, on *Aspidiotus perniciosus*.

In 1913, H. and P. Sydow instituted a new genus of *Sphaeriaceae*, *Coccidophthora*, parasitic on scale insects, on a specimen collected by Hara in Japan, the species being named *Coccidophthora variabilis*. In the following year, however, Hara stated that the specimen submitted to Sydow consisted of two fungi, a *Nectria* parasitic on a scale insect, and another ascigerous fungus parasitic on the *Nectria*. Hara named the *Nectria*, *N. variabilis*, and instituted a new genus for the super-parasite, which he named *Philonectria variabilis*.

In 1914, H. and S. Sydow described *Microcera Merrillii* on a scale insect from the Philippines.

Stevenson, in 1917, described a *Tubercularia* on *Lepidosaphes beckii* and *Hemichionaspis minor*, on Citrus in Porto Rico, as *Tubercularia coccicola*.

The species of *Nectriae*, or their probable conidial stages, which have been recorded as occurring on scale insects are:

Sphaerostilbe coccophila (Desm.) Tul. (1861).
Nectria aurantiicola B. and Br. (1873).
Nectria aglaothele B. and C.(1875).
Nectria coccorum Speg. (? 1886).
Nectria coccogena Speg. (1889).
Nectria coccophila Nomura (1901).
Nectria coccidophthora Zimm. (1901).
Nectria variabilis Hara (1914).
Ophionectria coccicola Ellis and Everhart (1886).
Ophionectria tetraspora Miyabe and Sawada (1913).
Puttemansia Aurantii von Höhnel (1911).
Scleroderris gigaspora Massee (1910).
Lisea Parlatoriae Zimm. (1901).
Broomella Ichnaspidis Zimm. (1901).
Microcera coccophila Desm. (1848).
Microcera rectispora Cke. and Mass. (1887).
Microcera tasmaniensis McAlp. (1904).
Microcera Mytilaspis McAlp. (1904).
Microcera Parlatoriae Trabut (1907).
Microcera curta Sacc. (1909).
Microcera Tonduzii Pat. (1912).
Microcera Fujikuroi Miyabe and Sawada (1913).
Microcera Merrillii Syd. (1914).
Microcera sp. Fawcett (1908).
Tetracrium Aurantii P. Henn. (1902).
Fusarium epicoccum McAlp. (1899).
Fusarium coccidicola P. Henn. (1903).
Fusarium Aspidioti Sawada (1914).
Tubercularia coccicola Stevenson (1917).

Of the twenty-nine species enumerated in the foregoing list, only nine are prior to the current century. The idea that fungi might be parasitic on scale insects and not on the plants on which they occurred appears to have spread very slowly, and, where the scale insect was not immediately evident, such species have been described without reference to their real host. Though the list is no doubt still incomplete, an examination of the species of *Nectria*, *Sphaerostilbe*, *Fusarium*, *Atractium* and *Microcera* in Herb. Kew and Herb. British Museum has shown that the following species are parasitic on scale insects.

Nectria diploa B. and C. (1868).
Nectria laeticolor B. and C. (1868).
Nectria subcoccinea Sacc. and Ellis (1882).
Nectria Passeriniana Cooke (1884).
Nectria oidioides Speg., *myrticola* Rehm.
Sphaerostilbe flammea Tul. (1861).
Atractium flammeum Berk. and Rav. (1854).
Fusarium coccinellum (Kalch.) Thuem. (1876).
Microcera pluriseptata Cke. and Massee (1888).

The following new species are described in this account:

Nectria Tuberculariae.
Nectria barbata.
Calonectria coccidophaga.
Podonectria echinata.
Patouillardiella Aleyrodis.
Fusarium Aleyrodis.

MICROCERA.

Desmazières described *Microcera* as clavate, composed of almost simple hyphae, and furnished with an external sheath, which is toothed at the apex. In his note, he stated that the sheath is closely adherent. The spores are fusiform and arcuate.

The Tulasnes overlooked the presence of the sheath, or if they saw it, did not understand that it was Desmazières' velum or volva. They stated that *Microcera* differed little from *Atractium*, and that some specimens matched the true *Stilbum* of Tode. From their remarks, and the inclusion of the fungus in the genus *Sphaerostilbe*, it is clear that they regarded *Microcera* as composed of parallel hyphae, like the usual *Stilbum*.

The fructification of *Microcera*, therefore, is a synnema, with *Fusarium*-like spores.

The generic descriptions of *Microcera* in the various text-books of mycology have carried on Desmazières' statement concerning the velum, but the fungus has been included in the *Tuberculariaceae*, whereas, in its fully-developed form, it belongs to the *Stilbaceae*. In actual practice, however, any fungus with fusarioid spores, which grew on a scale insect, has been assigned to *Microcera*.

One cannot examine many collections of fungi on scale insects from the tropics without noting that there are at least two distinct forms of conidial fungi, which have fusarioid spores. Parkin appears to have been the first to notice that. He de-

scribed the synnema of "*Nectria coccidophthora*" as having a closely adherent sheath, and that of the other form as having a loose sheath. But Parkin assigned the first, which is the true *Microcera*, to *Fusarium*, and called the second, *Microcera*. As he stated, the two forms are readily distinguished by the naked eye.

Sphaerostilbe flammea, *Nectria lacticolor*, *Nectria aurantiicola*, *Nectria subcoccinea*, *Nectria aglaothele*, and *Nectria coccidophthora* have the *Microcera* conidial fructification, and must all be classed as *Sphaerostilbe*. The second type of conidial fructification will be described as *Pseudomicrocera*; the only *Nectria* yet known to have this conidial stage is *Nectria diploa* B. and C.

The following description of *Microcera* has been drawn up principally from the tropical forms. Specimens from temperate countries, although their perithecial stages prove that they are the same species as those of the tropics, are usually so poorly developed that their structure can be ascertained only with considerable difficulty, and they must be regarded as depauperate examples of the tropical species. It is somewhat surprising that Desmazières recognised the real structure of *Microcera* from specimens collected in Europe, but it would appear from his account that he had a series of living specimens in various stages of development.

Fully developed specimens of *Microcera* (Plate III, fig. 1) are up to 2·5 mm. high, distinctly stilboid, with a stout terete stalk and an ovoid, subglobose, or flattened globose head. Smaller specimens may be clavate, expanding gradually upwards into the head (Plate III, fig. 8). The stalk is composed of parallel hyphae, which separate above and form the conidiophores. The latter give off branches repeatedly, at an acute angle, either alternately or unilaterally, the ultimate branches being usually very long. When the head is teased out, it separates into long brush-like pencils, each consisting of an original conidiophore with all its long branches.

The outer layer of the stalk hyphae do not separate to form conidiophores. They are united to one another laterally, and form a sheath, closely adherent to the stalk, which divides into long triangular teeth at the level of the head. The teeth do not recurve, but remain adherent to the head, and it is necessary to tease out the head in order to see them clearly. In small, or young, examples, the teeth extend almost to the apex of the head, but in larger examples they terminate some little distance below, along the side of the head, or even just above its base. Desmazières' account of the growth of the fungus appears to be correct. When the conidia have been dispersed the teeth may

converge, and form a pointed tip at the apex of the stalk (Plate III, fig. 5). In some instances, there are a few erect fascicles of hyphae, arising from the stroma, surrounding the base of the stalk.

The hyphae of the sheath are united here and there by ladder-connections, i.e. short junctions perpendicular to the hyphae (Plate V, fig. 16). These ladder connections are, however, much more common, and more easily found, between the unbranched bases of the conidiophores. They were noted by the Tulasnes.

The head, normally, is ovoid, but frequently it is curved into a hook, or produced into a point often perpendicular to the stalk. The latter form is, in a sense, accidental. The conidia do not fall off, or blow away, but remain united in a mass by some soluble substance. The fungus grows on scale insects attached to branches, as a rule, and consequently is most generally perpendicular to the branch. But as the branch is often erect or oblique, the mass of conidia bends downwards by its own weight, and thus may become perpendicular to the stalk. The occurrence of dozens of synnemata on the same branch, all with their heads curved in the same direction appears most remarkable until the reason is perceived.

The conidia of *Microcera* (Plate V, fig. 10) are typically narrow-cylindric, or fusoid, nearly straight with falcate tips, 60–120 μ long, 5–8 μ diameter, up to eleven septate, the ends subacute, the distal end being rather more obtuse than the proximal. Sometimes they are quite straight, and sometimes slightly and uniformly curved.

The species of *Microcera* on scale insects are orange red and subtranslucent when fresh, and become brownish red, hard, and horny when dry. When placed in water, the head expands and the outer conidia float off. The synnemata generally arise from a very narrow stroma round the scale; this stroma is tomentose, and, if of any considerable thickness, is composed of interwoven hyphae.

In addition to the stilboid form, reduced forms occur in all the known species of *Microcera*. These may be clavate, with a barely recognisable stalk, or quite sessile, flattened pulvinate, circular or oval in plan, usually seated on the narrow stroma at the margin of the scale (Plate III, fig. 2). These sessile forms may occur together with the stilboid form, or a gathering may consist entirely of either kind. The sessile fructifications are composed of closely packed conidiophores, which arise almost directly from the basal stroma; they are surrounded by a sheath similar to that of the stalked forms.

In the forms from temperate countries, the sessile form of

fructification usually predominates, and the stilboid form, if present, is generally small. Desmazières stated that the clava was scarcely 0·5 mm. high. In the specimen, Desmazières, Plantes Cryptogames de France, Ed. II, Ser. I, No. 1350, in Herb. British Museum, the synnemata are clavate, or conical, or flattened pulvinate; the clavate and conical examples are up to 0·6 mm. high, and 0·3 mm. diameter; the flattened pulvinate examples are up to 0·6 mm. diameter. In *Sphaerostilbe flammea*, Ellis, North American Fungi, No. 1333 (issued as *Nectria subcoccinea* Sacc. and Ellis), the synnemata are conical, 0·35 mm. high, 0·25 mm. diameter at the base, or flattened pulvinate, up to 0·5 mm. long, 0·25 mm. broad.

The sheath in the temperate forms differs from that in the tropical examples in that the teeth tend to divide above into separate hyphae. In some instances, however, the sheath forms a thin membrane which persists after the dispersal of the conidia. An example in Erbar. Crittogam. Ital., Ser. II, No. 542, from which all the conidia had disappeared, consisted of a short stalk 0·1 mm. diameter, surmounted by a membranous cup about 0·1 mm. high, no hyphal structure being discernible in the membranous edge.

Another point of difference lies in the relative development of the conidia and the conidiophores. In the tropical forms, conidia are produced abundantly and there do not appear to be any barren conidiophores or paraphyses: the outer part of the head is a mass of conidia. In the temperate forms, on the other hand, conidia are sparingly produced, and very many of the conidiophores appear to be barren. Desmazières noted that the conidia occurred among the filaments and were few in number, and in some pulvinate examples in his specimens, the barren (?) filaments are so numerous towards the exterior, that the fructification has a distinct white margin. The conidia too are less perfectly developed in the temperate examples. *Nectria aurantiicola* in the tropics has conidia with well-defined septa, while in *Microcera coccophila*, the septa tend to be obscure. But the conidia of *Nectria aurantiicola* from Italy, have obscure and irregularly arranged septa.

No criteria have been found by which it would be possible to distinguish with certainty between the *Microcera* stages of the different species of *Sphaerostilbe* parasitic on scale insects. It is necessary to have examples which have developed the perithecial stage.

Of the species which have been described as *Microcera*, *Microcera Parlatoriae* Trabut, *Microcera curta* Sacc., and *Microcera Tonduzii* Pat. are *Fusarium*, *Microcera Fujikuroi* Miyabe and Sawada and *Microcera Merrillii* Syd. are *Pseudomicrocera*.

Microcera tasmaniensis McAlp. and *Microcera Mytilaspis* McAlp. differ generically from *Microcera* and the foregoing species. *Microcera rectispora* Cke. and Massee is *Tetracrium*. *Microcera pluriseptata* Cke. and Massee, which was said to grow on *Calocera*, is on a scale insect, the supposed *Calocera* being the effete *Microcera* synnemata; this species is *Microcera coccophila* Desm.

PSEUDOMICROCERA.

The second type of conidial fructification which is common on scale insects in the tropics occurs on *Lepidosaphes* (*Mytilaspis*), *Aspidiotus*, *Fiorinia*, *Aonidia*, etc. It was named *Microcera Fujikuroi* by Miyabe and Sawada on specimens from Formosa in 1913, and *Microcera Merrillii* by Sydow on specimens from the Philippines in 1914. In Florida, it has generally been assigned to *Microcera coccophila* Desm., and the majority of the specimens distributed from Florida to European herbaria under that name are *Pseudomicrocera*. It is figured as *Microcera coccophila* by Fawcett in Fungi parasitic on *Aleyrodes citri*, fig. 14, and by Parkin as *Microcera* (figs. 62–66). As it is a common fungus, it may be expected to have been named in the earlier days of mycology without reference to its real host, but it has not been found among the species of *Fusarium* in Herb. Kew or Herb. British Museum. The earliest name yet found for it is *Aschersonia Henningsii* Koorders (type specimen in Herb. Berlin examined), described from specimens from Java in 1907.

The mature perithecial stage of this species has been collected in Brazil, Paraguay, Cuba and Ceylon, and immature perithecia have been found in a specimen from Mauritius. These are *Nectria diploa* B. and C.; the type specimen of the latter contains effete *Pseudomicrocera* sporodochia.

It has not been found possible to differentiate between the specimens of *Pseudomicrocera* from different countries, with the exception that specimens from West Africa have much longer spores than the others. For the present, they must all stand as *Pseudomicrocera Henningsii* (Koord.), while the West African form may be known as var. *longispora*. It is probable, however, that when further specimens of the *Nectria* stage have been collected, *Pseudomicrocera Henningsii* will be found to be a collective species.

The fungus (Plate III, figs. 9–12) forms a thin, but compact, stroma, sometimes glabrous and shining, either at one side of the scale, or as a narrow margin all round it. In some cases, e.g. on *Aonidia* (Plate III, fig. 9), the stroma also grows centripetally over the scale. From this stroma there arise conidial fructifications in varying numbers. In a few instances, no stroma

is visible, and the fructifications appear to arise from the margin of the scale. In general, the fructifications lie flat on the host plant, radiating from the scale, but they are frequently directed obliquely upwards. They are seldom, or never, quite erect.

Each conidial fructification (Plate III, fig. 11) consists of an ovoid, subcylindric, or cushion-shaped base, contracted above and below, as a rule, and surmounted by a conical tip. The distinction between the basal portion and the conical tip is usually well-marked, as the two parts differ both in colour and structure. But in some cases the base is reduced to a height of about 0·2 mm. or less, and then only the conical tip is immediately evident (Plate III, fig. 12).

In well-developed examples, the basal part is ovoid, red, minutely rough, pruinose, and opaque, and has the appearance of a red *Nectria*. In general, however, the base is broader than it is long or thick, and may have a breadth of 0·6 mm., with a height of 0·2 mm. Its sides are usually curved, so that it is constricted above and below, but in the form on *Aonidia* (Plate III, figs. 9, 10) there may not be any constriction above, and the fructification then tapers gradually from the point of attachment to the apex. In small examples, the base is often translucent.

The conical tip consists of long, parallel hyphae, united into narrow triangular teeth, or sometimes into a sheet which is almost continuous. These teeth converge at the apex, in general, but they may stand more or less parallel to one another. As a rule, the tip greatly exceeds the base in length. It may be pinkish when fresh, but on old examples, or in herbarium specimens, it is white.

In the majority of specimens the base is composed of interwoven hyphae. These hyphae are irregular, rather closely septate, constricted at the septa, and with strongly inflated segments, or moniliform, consisting of a chain of more or less rounded cells. These cells are usually filled with a red plasma. The stroma from which the fructification arises has the same structure. The hyphae in this case separate under pressure. They have been figured by Miyabe and Sawada for *Microcera Fujikuroi*.

In the larger examples the development of the base has advanced further, and the hyphae are fused together so that the base is parenchymatous. This happens in the common Ceylon form on *Lepidosaphes*, etc., but it is most frequent and most clearly evident in specimens from Florida and the West Indies. In section the base consists of polygonal thick-walled cells, without coloured contents, hyaline in the centre, but reddish, or red-brown, towards the exterior.

Further details of the structure of this conidial fructification are most easily ascertained from these larger examples. Longitudinal sections show the following.

Towards the top of the parenchymatous base, the cells, though still irregular, become more elongated in a longitudinal direction. This is more especially marked in the central portions. From these elongated cells, there arise short conidiophores which form a continuous disc over the upper surface of the parenchymatous base. The marginal cells of the base, however, give rise to long, septate hyphae which are united into fascicles. These fascicles converge above and constitute the conical apex. Viewed from the exterior they are long-triangular: in section they are several hyphae thick at the base, and in some cases there is, at the base of the fascicle, a distinct inner and outer layer of parallel hyphae separated by a layer of parenchymatous tissue which gradually becomes thinner and disappears at a short distance from the base. On the inner side of these fascicles there may be a small number of long, septate hyphae, similar to those which form the fascicles, but free, and constituting "paraphyses."

The structure consequently resembles that of a Discomycete. The parenchymatous base is to some extent differentiated into a "hypothecium" of elongated cells which bear the conidiophores, and an "epithecium" of more isodiametric cells. The long marginal hyphae arise from the uppermost cells of the "epithecium."

This structure is illustrated diagrammatically on Plate V, figs. 20 and 21. Fig. 20 shows the base and the tip viewed from the lower surface, the wall of the tip being shown as continuous. Fig. 21 is a longitudinal section of a well-developed specimen with a parenchymatous base and the teeth on the upper side longer than those on the lower.

The conical tip was designated by Parkin a "loose sheath" in contradistinction to the "closely adherent sheath" of *Microcera* (*Fusarium* of Parkin). But, although it resembles the latter in being composed of long, septate hyphae, which are united by ladder connections, it differs from it in several particulars. It is not a continuation of the outer layer of the base, but differs entirely in structure from the latter. It is composed, at least in the lower part, of several layers of adherent hyphae. It does not sheath the bases of the conidiophores but is a marginal border to a slightly concave disc, and encloses a mass of detached conidia.

In many cases, the hyphae which constitute the segments of the tip are not of the same length all round the disc. It has already been stated that the fructification is rarely erect, but usually horizontal and often oblique. The hyphae of the teeth

on the lower side are often shorter than those on the upper. Consequently, when the fructification is viewed from below, large specimens show an oval opening, through which the orange-coloured disc may be visible. The sporodochium then resembles a small *Otidea*.

The marginal hyphae may be united into a continuous layer surrounding the disc, or divided into teeth or segments to varying depths from the apex. In some forms, this envelope is continuous up to the apex on the upper side, and divided down to the base in the median line on the lower.

The conidiophores are short, as a rule. They are at first unbranched and about 30 μ long, but become branched and about 60 μ long. They resemble the conidiophores of *Microcera* in diameter and branching, but are very considerably shorter. It is possible that they may attain a greater length in some species, but in all the cases observed, the ultimate branches are short, and the conidiophore branched almost from the base. Probably because of the shortness of the conidiophores, ladder connections between them are absent, or at least rare.

The conidia are long, three to five septate with long aseptate tips, and, in the forms examined, are usually regularly curved from tip to tip (Plate V, fig. 17). They remain for some time enclosed within the tip in an orange, or coral-red, mass, the apex of which projects slightly, but, judging from the available specimens, they are more readily dispersed than those of the true *Microcera*.

The structure of this conidial form is evidently quite different from that of the *Microcera* described by Desmazières; and it does not appear to agree with any existing genus. I therefore propose for it a new genus, *Pseudomicrocera*.

Pseudomicrocera. Sporodochium conical; base ovoid, or cylindric, or pulvinate, parenchymatous, or composed of interwoven irregular hyphae, surmounted by a discoid layer of conidiophores with a marginal zone of long hyphae, united into a continuous sheet or into fascicles of varying breadth, which are connivent at the apex; conidiophores branched; conidia elongated, narrow, curved, septate, hyaline.

The following forms of *Pseudomicrocera* have been examined.

A. Specimens on *Aspidiotus* on *Citrus*, Florida, U.S.A. (Plate III, fig. 11), and on *Aspidiotus* and *Ischnaspis filiformis*, on Coffee, Grenada, West Indies.

The sporodochia are oblique or horizontal. The scale at first has a radiating byssoid margin, which develops into a more compact yellowish-white stroma, at the side of, or covering, the scale. The sporodochia may arise from the margin of the scale, or from the stroma. In some cases the sporodochium arises at

the side of the scale from a more or less circular, thin, parenchymatous disc, which separates from the leaf with the sporodochium. The stroma may be floccose or parenchymatous.

The total height of the sporodochium is, as a rule, up to 0·8 mm., but specimens up to 1·5 mm. high occur. The base is subcylindric, but usually broader than high, and somewhat compressed from front to back. Large specimens have a base 0·6 mm. broad, and 0·5 mm. high; in smaller examples, it is about 0·5 mm. broad and 0·3 mm. high. The base is pinkish-red, opaque, with a delicate white pruina, and is usually contracted above and below. The tip is conical, longer than the base, white or pinkish, divided into segments or teeth to varying depths. The teeth are shorter on the lower side of the sporodochium, and, hence, when it is viewed from the lower side, the orange-red disc is visible through an elongated oval opening, more especially in the larger specimens.

In section, the base of the larger specimens is parenchymatous, being composed of polygonal, rather thick-walled cells, 4–6 μ diameter, with a few 10 μ diameter. The exterior cells are smaller than those in the interior and have reddish walls. The hyphae of the tip are 4 μ diameter, equal, septate, united by ladder connections. In large specimens, the teeth are up to 120 μ thick at the base on the upper side, and 60 μ thick in the corresponding position on the lower. The conidiophores are simple, or closely branched, 3 μ diameter, equal, up to 50 μ long in the centre of the disc, longer towards the margin.

The conidia are arcuate, sometimes almost straight with curved tips, generally three-septate, but sometimes four- or five-septate, hyaline; in the Florida specimen they measure 60–70 × 3–5 μ; in the Grenada specimen, 50–66 × 3 μ, measurements made straight from tip to tip. In the latter specimen, the conidia tend to collapse laterally.

This form differs from the common Ceylon form in that the base is more usually parenchymatous, and the conidia, on the average, are shorter.

B. On *Lepidosaphes, Aspidiotus, Fiorinia, Ischnaspis,* from Ceylon, India, Australia, Mauritius, Java, and Formosa (Plate IV, fig. 12).

The stroma is narrow, compact, slightly irregularly pulvinate, tomentose, with a radiating byssoid margin. The marginal hyphae tend to fuse into a membranous hyaline sheet. The stroma may completely surround the scale or be confined to one side. As a rule it does not grow over the scale, but it may completely cover small examples. In some cases, the sporodochia appear to arise direct from the scale, no stroma being visible externally. The sporodochia are horizontal, as a rule.

The base of the sporodochium is pulvinate, pinkish-red, opaque or subtranslucent, tomentose, 0·2 to 0·6 mm. broad, and 0·06 to 0·2 mm. high. The total height of the sporodochium is up to 0·6 mm. The marginal teeth are long, triangular, divided down to the base, usually connivent, either of equal length all round, or shorter on the lower side.

In herbarium specimens the stroma and base of the sporodochium become yellow.

The conidia are arcuate, equally curved, hyaline, three- to five-septate. Measurements from different gatherings have given, 80–100 × 4 μ; 80–90 × 4–4·5 μ; 82–92 × 3–5 μ (Mauritius); 76–94 × 4 μ; 74–92 × 3–4 μ.

I have examined the following collections of this form. On *Fiorinia rubrolineata* on *Murraya exotica*, Ceylon. On *Ischnaspis* sp. on *Funtumia*, Ceylon. On *Lepidosaphes* sp. on orange, Ceylon. On *Mytilaspis pallida* on *Codiaeum variegatum*, Ceylon (Parkin's specimen). On *Aspidiotus* sp. on *Hevea*, Ceylon. On *Fiorinia fioriniae* on *Camellia*, Mauritius (Parkin's specimen). On a diaspid on Tea, Java. On *Aspidiotus* on orange, Jorhat Farm, Assam (E. J. Butler). On scale on *Indigofera*, Bassein, Burma (E. J. Butler). On *Aspidiotus ficus* on *Citrus*, Port Darwin, N.T., Australia.

Specimens of *Microcera Fujikuroi* Miyabe and Sawada from Herb. Sapporo have been kindly lent me by Prof. Ito. One, on *Aspidiotus ficus* Comst. on *Citrus nobilis*, Sensoho, Formosa, October 30, 1906, has stromata either hidden by the scale, or forming a narrow border on one side, or covering the scale except in the centre. The sporodochia are horizontal, spreading stellately from the scale. The base is small, about 0·1 mm. high. The conidia are curved, equally attenuated, usually five-, sometimes six-septate, with long aseptate tips, 72–94 × 3–4 μ; they tend to collapse laterally, like those of the West African form noted below. The hyphae of the teeth are slightly stouter, and have thicker walls, than in specimens from other countries, but in other respects they do not differ from the Ceylon form on *Aspidiotus*.

The type specimen of *Microcera Fujikuroi*, on *Aspidiotus ficus* Comst. on *Citrus nobilis*, Taihoku, Formosa, February 29, 1908, is identical with the foregoing, but poorly developed. From Prof. K. Hara, I have received specimens on *Abies firma*, Shizuka, October, 1918.

A specimen, *ex* Herb. Victoria, on *Aspidiotus ficus* on *Citrus*, Port Darwin, N.T., July 13, 1915, has a narrow, pink, fimbriate stroma round the scale, with the sporodochia lying horizontally on the leaf or emerging from the apex of the scale. The sporodochia are variable, some having an opaque base, 0·1 mm. high,

with a white tip 0·3 mm. high, while others appear wholly translucent, the tip being filled with an orange-yellow mass of conidia. The conidia are of the usual form, or almost straight with curved tips, up to five-septate, 70–90 × 4 μ.

In another Australian gathering, on *Lepidosaphes* sp. on *Melaleuca leucadendron*, Stapleton, N.T., the stroma is dark red, subtranslucent, irregular, either situated at one side of the scale or overgrowing it completely. It is somewhat adhesive, and though the specimen was collected about fifteen years ago, it still adheres to paper if lightly pressed. The sporodochia have broad bases, up to 0·4 mm. broad, and 0·3 mm. high, but in some the base is almost absent. The bases have the same colour and appearance as the stroma, and are slightly longitudinally tomentose. The tip is short, white, conical, up to 0·15 mm. high, sometimes represented by a few scattered teeth only, in the available specimens. The conidia are arcuate, equally curved, tapering regularly to the tips, a few nearly straight, generally five-septate, 72–94 × 4 μ. This differs from the common Ceylon form in its shorter tip and subtranslucent waxy stroma.

Microcera Merrillii Syd. (Ann. Myc. XII, p. 576), on a scale on *Eugenia perpallida* from the Philippines, would appear to resemble the foregoing. I have examined the co-type, S. 259, Herb. Bureau Sci. Philippines, which contains very few stromata, and those all immature. The stromata are dark red, subtranslucent, waxy, covering the scale or spreading from it on one side rather more widely than in the usual form. The largest stroma found was flattened convex, about 0·8 mm. diameter. The structure of the stroma is not that of the true *Microcera* but that of *Microcera Fujikuroi*. Sydow describes the sporodochia as pale blood red, sessile, generally confluent in small masses 1–1·5 mm. diameter, and the conidia narrow fusiform, straight or subfalcate, three-septate, with acute tips, 40–60 × 3·5–4 μ. I was unable to find conidia in the co-type, but those described by Sydow evidently agree with those of *Microcera Fujikuroi*, not with those of *Microcera coccophila*. Sydow compared his species to *Microcera tasmanica* McAlp., but it has not the structure of the latter.

Both *Microcera Merrillii* and the Australian specimen on *Melaleuca* yield a white precipitate when treated with alcohol. That characteristic, however, is not confined to these subtranslucent forms, but has been noted in an opaque form from Grenada.

Hennings in 1903 (Engler's Bot. Jahrb. p. 57) described *Fusarium coccidicola* on a coccus on leaves of Tea, Ost-Usambara, East Africa. The sporodochia were said to be effused, waxy, cinnabar, with fasciculate, simple, septate, rosy-hyaline hyphae,

100–250 × 4 μ. The conidia were elongato-fusoid, falcate, multiguttulate or obsoletely septate, with subacute tips, pinkish hyaline, 80–100 × 3·5–4 μ. I have not seen the type specimen, but from the description of the stroma and the conidia, this would appear to be *Pseudomicrocera*.

C. Specimens on *Aspidiotus articulatus* on Coffee, Soto, West Africa. This collection was enumerated by Parkin. In general appearance, it resembles the Ceylon specimen on *Aspidiotus* on *Hevea*. In some cases the scale is surrounded by a narrow stroma, with a fibrillose margin which may spread out over the leaf for a distance of two or three millimetres; in others, no stroma is visible, and the bases of the sporodochia are partly hidden by the scale. The sporodochia lie flat on the leaf, radiating in star fashion from the scale. Their bases are small, not exceeding 0·2 mm. in height, but the white tip is well developed. The teeth are distinct down to the base; viewed from the lower surface, they may be widely separated or not. The conidia are of the usual type, arcuate, equally curved, with tapering points, three- to five-septate, readily collapsing, 92–134 × 3 μ.

This form differs from the common Ceylon species, only in the greater length of its conidia. It may be known as var. *longispora*.

D. Specimens on *Aonidia*, Ceylon. Specimens on *Aonidia crenulata* on *Memecylon* (Plate III, figs. 9, 10), and *Aonidia bullata* on *Nothopegia Colebrookiana* were described by Parkin. The former is common on a group of *Memecylon edule* in the Royal Botanic Gardens, Peradeniya; of the latter, I have only the specimens referred to by Parkin.

On *Aonidia crenulata*, the fungus forms a narrow stroma, up to 0·25 mm. wide, either all round, or at one side of, the scale. This stroma is pinkish-red, thin, compact, with a whitish, fimbriate margin, and often radially grooved. It usually grows centripetally over the scale, as well as centrifugally over the leaf, but the centre of the scale is generally left exposed. The scale appears red, or scarlet, owing to the growth of the fungus beneath it, and the naked centre is more vividly coloured than the stroma. In wet weather, the stroma is coral red; when dry, it has a delicate covering of scattered, whitish hyphae.

The sporodochium almost always arises at the inner edge of the stroma, so that it is perched on the top of the scale, as a rule. Also, it usually arises from the extreme edge, and is attached to the stroma, not over its whole base, but at one side, so that at first sight it appears to be disconnected from the stroma. Generally only one sporodochium is borne on each scale, but there may be two. It is usually oblique, rarely horizontal.

The total height of the sporodochium is up to 0·9 mm. The base is ovoid or cylindric, 0·4 mm. high and 0·3 mm. diameter, with a conical tip, 0·5 mm. long. When moist, the whole fungus is subtranslucent, pinkish-red or coral-red, but when dry it appears whitish or pinkish, and minutely pruinose.

The wall of the conical tip may be divided into teeth, as in the common form, but it is frequently continuous, except for a fissure extending along the whole length of the tip in the median line on the lower surface. Sometimes this fissure is narrow, rather broader above than below: in other cases, its sides are curved as shown in diagram 20, Plate V. The hyphae which form the wall of the tip are 4 μ in diameter, equal, septate, and united by ladder connections. The wall is rather thick and fimbriate at the apex, and numerous long free hyphae, parallel, and similar to those which compose the wall occur on the inner side.

In dry-weather forms, the sporodochium is uniformly conical without any evident constriction between the base and the tip. At other times, the sporodochium is constricted, and often curved.

The conidiophores are short, 30–66 μ, simple or branched. The conidia are arcuate, tapering uniformly to the ends, usually three-septate, a few five-septate. The septa are obscure, and apparently tardily developed. It is not uncommon to find the majority of the spores without septa. The aseptate tips are usually long, up to 20 μ. Measurements of different collections have given the following dimensions: 70–86 × 4 μ; 84–96 × 3·5–4 μ; 66–82 × 3·5–4 μ; 38–64 × 3–4 μ, some only 16–30 μ (dry weather); 70–80 × 3·5–4 μ.

When the tip is filled with spores, the mass projects at the apex as a coral-red point.

The specimen on *Aonidia bullata* mentioned by Parkin is similar to the above, but the sporodochia arise in the middle of the stroma, not at its edge. The spores are arcuate, three-septate, 70–80 × 4 μ.

A curious abnormality of the form on *Aonidia crenulata* has been collected. It occurred on *Memecylon* with the normal form, the latter usually on the under surface of the leaf, and the abnormal form on the upper. No scale insects were visible on the upper side of the leaf, but it was covered with small, curved, hyaline, claw-like thorns, standing up obliquely. Each of these thorns arises from a broad, circular, hyaline, membranous, scarious patch up to 0·8 mm. diameter, which can readily be detached from the leaf. The thorn-like projection is about 0·6 mm. high, strongly laterally compressed, and about 0·25 mm. broad. The convex edge is regular, but the lower edge, viewed

from the side, appears to be interrupted by a deep narrow sinus (Plate V, fig. 8 *b*). Viewed from the convex edge, two auricles are seen, projecting one on either side at the base (fig. 8 *a*), while, from the concave side, it is seen that the two sides of the structure fold together and nearly meet above, but separate again widely near the base (fig. 8 *c*).

The wall of this structure is thin, continuous, and hyaline, and is composed of parallel hyphae, about 3 μ diameter, united side by side in a continuous sheet, and joined laterally by ladder connections. Within it, at the base, there is a very minute parenchymatous mass of hyaline cells, from which a few unbranched conidiophores arise, but no conidia have been found.

A comparison of figs. 8 and 20, Plate V, will make it clear that these thorns are the walls of the conical tips of the *Pseudomicrocera*, and their structure supports that interpretation. But they are not *Pseudomicrocera* sporodochia from which the conidia have disappeared, as the base is practically entirely lacking. For some reason, only the wall of the tip has been developed, and that has taken the form of a hyaline membrane. They appear to have grown on very small specimens of *Aonidia*.

It may be noted that the tendency to produce scarious membranes is well-marked in most of the fungi which grow on scale insects. It occurs, for example, in *Aschersonia* and *Hypocrella*, where the stroma is often surrounded by a scarious hypothallus; and one may meet with the same hypothallus, indiscriminately, in gatherings of *Sphaerostilbe* and *Microcera*.

SPHAEROSTILBE.

Sphaerostilbe coccophila Tul.

This species was first described by the Tulasnes in Selecta Carp. Fung. I, p. 130 (1861), where they cited the specimens *Microcera coccophila* Desm., Desmazières, Plantes Cryptogames de France, Ed. II, Ser. I, No. 1350 as the conidial stage, and Rabenhorst, Fungi Europaei Exsicc., Ed. nov., Ser. secunda, Nos. 262 and 269 as the perithecial stage. Rabenhorst 262 had been issued as *Nectria episphaeria* Tode, and 269 as *Microcera coccophila* Desm.

The description was repeated in Selecta Carp. Fung. III, p. 105, where Rabenhorst 262 only is cited for the perithecial stage, but Desmazières, Plantes Cryptogames de France, Ed. I, Ser. I, No. 1750 is added to the former citation for the conidial stage.

Desmazières 1350 and 1750 were collected near Caen (Normandy) and Rabenhorst 262 and 269 at Florence, Italy.

According to the Tulasnes' description, their species forms a

narrow byssoid stroma, pallid or pale rose, round the scale. The synnema is about a line high, with a deep red head consisting of linear lanceolate, curved conidia, three- to five-septate, 65 × 6 μ. The perithecia arise at the base of the synnema, or on stromata which lack synnemata; they are minute, globose, obtusely and very shortly papillate, very smooth, shining red, fleshy and fragile, collapsing when dry, clustered in groups of three to five. The asci are cylindric, 60–80 × 6·5 μ, obtuse, subsessile, eight-spored. The ascospores are ovate, subhyaline, one-septate, somewhat constricted at the septa, ends obtuse, 10 × 5 μ.

Seaver (Mycologia, 1, p. 180) regards *Sphaerostilbe coccophila* Tul. as identical with *Nectria subcoccinea* Sacc. and Ellis, and suggests that it is also identical with *Nectria aurantiicola* B. and Br. and *Nectria aglaothele* B. and C. He states that the synnema consists of a short stout stalk with an orange head, the conidia being straight, or more often curved, fusiform, three- to seven-septate, 50–90 × 5–6 μ, occasionally shorter; and that the perithecia are more or less caespitose, bright orange, with a prominent, rather acute ostiolum, and contain cylindrical asci, 75 × 8–10 μ, with elliptical or subelliptical spores, 12–18 × 7–9 μ. He cites the American specimens, Ellis, North American Fungi, No. 1333 (issued as *Nectria subcoccinea*); Ravenel, Fung. Car. Exsicc., No. 57 (issued as *Nectria muscivora* Berk.); and Hume, Florida, No. 39. The dimensions given for the ascospore give occasion for doubting the identity of the fungus described by Seaver with that described by the Tulasnes.

Von Höhnel and Weese state that *Nectria subcoccinea* Sacc. and Ellis (1882) is identical with *Nectria Colletiae* Rehm (1898) and *Nectria coccidophthora* Zimm. (1901) *from the descriptions*; and again that *Nectria Colletiae* Rehm is identical with *Nectria subcoccinea* Sacc. and Ellis, and, *fide* Seaver, with *Sphaerostilbe coccophila* Tul.

In order to clear up the synonymy suggested by the authors cited, an examination has been made of as many as possible of the type specimens, or of authentic specimens, of the species referred to. *Nectria Colletiae* Rehm is the only species not available in Herb. Kew, Herb. British Museum, or Herb. Peradeniya. The conclusions arrived at are stated here briefly; reference to the specimens examined will be made when dealing with the species individually.

To differentiate accurately between the different species of *Microcera* it is necessary to have the perithecial stages. In the conidial stage, they are all very similar, and though it appears possible to distinguish the conidia of *Microcera coccophila* from those of *Microcera aurantiicola* when both have been collected

in the tropics, the distinction fails when the specimens have originated in temperate countries.

The Tulasnes noted that in their perithecial specimens from Florence, Rabenhorst 262 and 269, the conidial stage was rare. In the specimens in Herb. British Museum and Herb. Kew, Rabenhorst 262 is apparently entirely perithecial, while Rabenhorst 269 contains the conidial stage, as well as immature perithecia. The latter is a poor development, the scales being scattered, not crowded as in other specimens from Florence. Although Rabenhorst stated, in the description which accompanied the specimen, 262, "ascos non vidi," it contains mature perithecia, and from these it is evident that the species is identical with that described from Ceylon by Berkeley and Broome as *Nectria aurantiicola*.

The conidial stage in Desmazières 1350 will be described later. But the specimens also contain perithecia, and these are identical with *Sphaerostilbe flammea* Tul.

Sphaerostilbe flammea differs from *Nectria aurantiicola* both in its perithecia and its ascospores. Consequently, *Sphaerostilbe coccophila* Tul., according to the specimens cited by the Tulasnes, consists of the perithecial stage of one species and the conidial stage of another. The Tulasnes named their species on the assumption that Desmazières' fungus was the same as that from Florence. But *Microcera coccophila* Desm. is the conidial stage of *Sphaerostilbe flammea*, not of *Sphaerostilbe* (*Nectria*) *aurantiicola*.

The synonymy quoted above (p. 110) is correct in that *Nectria aglaothele* and *Nectria subcoccinea* are identical with the species issued by Ravenel as *Nectria muscivora*; but they are not identical with the perithecial stage of *Sphaerostilbe coccophila*, though their conidial stage is *Microcera coccophila*. Nor are they identical with *Nectria aurantiicola* or *Nectria coccidophthora*.

It might be suggested that, as the perithecial stage of *Sphaerostilbe coccophila* is identical with *Nectria aurantiicola*, the latter name should be discarded. It would, however, still be necessary to retain *Microcera coccophila* for the conidial stage of *Sphaerostilbe flammea*, and the use of the same specific name for the two different stages of two different, though closely allied, species would undoubtedly lead to confusion. Moreover, it is quite certain that the Tulasnes' name was chosen on erroneous grounds.

One is loth to propose the abolition of a name which has been so widely employed in the literature of economic mycology. On the other hand, this reluctance is tempered by the knowledge that the name has usually been wrongly applied. *Sphaerostilbe coccophila* Tul., as it stands at present, is a compound species,

and it would certainly appear preferable to employ the names of species which have been more accurately defined, viz. *Sphaerostilbe flammea* Tul., *Sphaerostilbe aurantiicola* (B. and Br.), and *Sphaerostilbe coccidophthora* (Zimm.).

The three species of *Sphaerostilbe* parasitic upon scale insects, though undoubtedly closely allied, may be distinguished by the following characters.

Sphaerostilbe flammea Tul. Perithecia usually caespitose on a well-developed stroma, bright orange red, glabrous, globose, collapsing centrally; ostiolum minute, conical or inconspicuous; ascospores 12–19 × 5–8 μ.

Sphaerostilbe aurantiicola (B. and Br.). Perithecia usually scattered without evident stroma, dark red, subtranslucent, conoid, glabrous or with a few yellow granules, collapsing laterally; ostiolum papillate; ascospores 9–14 × 4–6 μ.

Sphaerostilbe coccidophthora (Zimm.). Perithecia usually scattered on a slight stroma, dark red, covered with yellow granules, conoid or subglobose, subtranslucent, collapsing laterally; ostiolum papillate; ascospores 13–22 × 7–9 μ.

In *Microcera coccophila*, the conidia are more often fusoid and straight from tip to tip than in *Microcera aurantiicola*; the typical conidium of the latter, and of *Microcera coccidophthora*, is almost straight with falcate tips. In *Microcera aurantiicola*, the septa of the conidia are usually more strongly defined than in *Microcera coccophila* or *Microcera coccidophthora*.

Berkeley and Broome described the perithecia of *Nectria aurantiicola* as "in stromata erecto sitis," and they gave a figure illustrative of that. Their description and figure are supported by a specimen *ex* Herb. Broome in Herb. British Museum, which shows that the erect stroma is a *Microcera* synnema. Parkin, in his figure No. 9, showed the perithecia situated in two instances on the stalk of the synnema. That, however, is not the usual mode of occurrence of the perithecia in *Nectria aurantiicola* and it is exceptional, even in Broome's specimen. In the most general case, the perithecia occur on scale insects which do not bear the conidial stage. When they occur in company with the conidial stage, they do sometimes occur on the stalks of the old synnemata, and developing perithecia may also be found in the head among the conidia. But out of about twenty Ceylon gatherings, I have only one in which they occur in those positions No. 542, Erbar. Crittogam. Ital., Ser. II, issued as *Sphaerostilbe coccophila*, also bears developing perithecia on the synnemata.

The Tulasnes figured *Sphaerostilbe flammea* with developing perithecia on the synnema. The type specimen of *Nectria laeticolor* B. and C. which is *Sphaerostilbe flammea* has perithecia

in that position in some instances, and the same is true of the type specimen of *Microcera pluriseptata* Cke. and Massee, which is identical with *Microcera coccophila* Desm., the conidial stage of *Sphaerostilbe flammea*. This has not yet been observed in *Sphaerostilbe coccidophthora*, but the available collections of the latter species are few in number.

Relying upon Berkeley and Broome's description and figures, von Höhnel has transferred *Nectria aurantiicola* to *Corallomyces* because it has perithecia on the synnemata. Obviously, in that case, *Sphaerostilbe flammea* must be transferred to *Corallomyces*, and this has been effected by von Höhnel in Herb. Kew, as far as regards the type of *Nectria laeticolor*. On this classification, the closely-allied *Nectria coccidophthora* must be left in *Sphaerostilbe*. But the production of perithecia on the synnemata is exceptional in both *Sphaerostilbe aurantiicola* and *Sphaerostilbe flammea*, and it does not seem reasonable to separate those two generically from *Sphaerostilbe coccidophthora* on a character which is seldom developed.

The genus *Corallomyces* was established by Berkeley and Curtis in 1853, the type species being *Corallomyces elegans*, described from specimens from Surinam in the Schweinitz Herbarium. It was said to have a branched stroma, with filiform and palmate branches, and to be a Hypocreaceous genus corresponding to *Xylaria*. Berkeley and Curtis published figures of their species (Journ. Acad. Sci. Philadelphia, n.s. II, Table XXV, fig. 2), showing short, simple, or slightly branched, clavae, in one case flattened at the tip. Another figure, by Lindau, was published in Engler-Prantl., Pflanzenfamilien, Th. 1, Abt. 1, p. 366; it shows a shrubby growth of suberect, much branched stems, arising from the same point. The latter figure is said to be original, but there is no indication of the origin of the specimen from which it was taken. The type specimen of *Corallomyces elegans* in Herb. Kew, "*Corallomyces elegans* B. and C., *Sphaeria pseudovillosa* Schw., Surinam, Herb. Schwein." is a dense group of old synnemata, arising side by side from the substratum; some of these are once branched, others simple, and there appear to be a few horizontal rhizomorphs in addition; the perithecia are borne on the old synnemata. There is nothing in the type specimen which would support Lindau's figure.

Corallomyces is merely a *Sphaerostilbe* which has produced perithecia on the old synnemata. The type species, *Corallomyces elegans*, is closely allied to *Sphaerostilbe repens*, a rhizomorphic species which may produce perithecia on the rhizomorphs or on the old synnemata. It would appear to be the rule rather than the exception, that species of *Sphaerostilbe* may produce

perithecia on the old synnemata. The distinguishing character of *Corallomyces* is the possession of a branched, filiform stroma, resembling that of a *Xylaria*, but that is based on a mistaken interpretation of the type specimen. Von Höhnel places in *Corallomyces* those species of *Nectria* which have the perithecia situated on a stalk-like stroma; in dealing with *Nectria aurantiicola*, he states (Fragm., No. 729) "Da die Perithecien auf einem stielartigen Stroma entstehen ist der Pilz eigentlich ein *Corallomyces*." But he does not appear to recognise that the stalk-like stroma is an old synnema, nor that the occurrence of the perithecia in that position is exceptional.

The Tulasnes employed the name *Sphaerostilbe* in Selecta Carp. Fung. I, 130 (1861), though they did not publish the generic description until 1865, in vol. III, p. 99. They included in the genus (in the following order), species with minute simple conidia and a *Stilbum* conidiophore, viz. *Sph. aurantiaca*, *Sph. gracilipes*, and *Sph. cinnabarina*, and species with long lanceolate, septate conidia and a *Microcera* conidiophore, viz. *Sph. flammea* and *Sph. coccophila*. Their genus is evidently heterogeneous, as it contains species which differ in their conidial stages, and it can be naturally divided into two genera, one with simple conidia and the other with lanceolate, septate conidia.

Corallomyces is prior to *Sphaerostilbe*. If the generic character assigned to the former is accepted, it will be necessary to retain both genera, and to transfer species from *Sphaerostilbe* to *Corallomyces*, when specimens of known species of *Sphaerostilbe* are collected which have developed perithecia on the old synnemata. And in that case both *Sphaerostilbe* and *Corallomyces* will be heterogeneous, for the latter must contain *Sph. repens*, with simple conidia, and *Sph. flammea*, with septate conidia, while the former will contain the parallel species, *Sph. aurantiaca* and *Sph. coccidophthora*. Alternatively, the misinterpreted generic character might be discarded, and all species of *Sphaerostilbe* referred to *Corallomyces*, but *Corallomyces* would still be heterogeneous.

The most logical course would appear to be to discard the false generic character of *Corallomyces*, and to include in the genus all species which are co-generic with the type specimen, *Corallomyces elegans*. The latter has *Nectria* perithecia, and a stilboid conidial stage with simple conidia, and is co-generic with *Sph. repens*, *Sph. variabilis*, *Sph. aurantiaca*, *Sph. gracilipes*, and *Sph. cinnabarina*. *Corallomyces* will then be equivalent to the first section of *Sphaerostilbe* of Tulasne, while the name *Sphaerostilbe* can be retained for those species which have a *Microcera* conidial stage and long septate conidia, viz. *Sph. flammea*, *Sph. aurantiicola*, and *Sph. coccidophthora*.

Corallomyces, Char. emend. Perithecia of *Nectria*; conidial stage stilboid; conidia continuous.

Sphaerostilbe, Char. emend. Perithecia of *Nectria*; conidial stage *Microcera*; conidia elongated, septate.

In re-describing *Microcera coccophila*, the Tulasnes stated that *Microcera* differed little from *Atractium* Link. Link established the genus *Atractium* in Magazin Gesellsch. Naturforsch. Freunde zu Berlin, Jahrg. III, 1809, p. 10, the type species being *Atractium Stilbaster*, and the generic characters, "Stroma elongatum, capitatum. Sporidia fusiformia, *non septata*, capitulo instrata." Link's figure shows a *Stilbum* with minute oval conidia; his type species is listed in Saccardo as *Atractium gelatinosum* (Pers.) Sacc. Subsequently (*ibid.* VII, p. 32) Link included in his genus *Atractium ciliatum* (*Tubercularia ciliata* Alb. and Schw.), with the note that he had seen septate conidia in this plant; the latter now stands as *Volutella ciliata*. Hence Link tacitly extended his genus to include species with septate spores, and in this he was followed by Berkeley and Saccardo, who published an amended generic description in Michelia, II, p. 32, citing *Atractium Therryanum* Sacc. as their type species. The genus *Atractium* would appear to require revision, but that is not relevant to the present discussion. The Tulasnes' statement is probably to be explained on the supposition that their knowledge of *Atractium* was based on the specimens sent to them by Berkeley as *Atractium flammeum* Berk. and Rav., since the latter species is identical with *Microcera coccophila* Desm.

Sphaerostilbe flammea Tul.

This species was described by the Tulasnes in 1856 as *Stilbum flammeum*, the name being changed to *Sphaerostilbe flammea* in 1861. Its conidial stage had been described by Berkeley in 1854 as *Atractium flammeum* Berk. and Rav. That *Sphaerostilbe flammea* is parasitic on scale insects appears to have escaped notice hitherto, though that is the case with all the specimens enumerated below. When its real host has been observed, the perithecial stage has been re-named, or the conidial stage has been correctly referred to *Microcera coccophila* Desm. (1848), which is identical with *Atractium flammeum* Berk. and Rav. (1854).

The fungus forms a white or pinkish tomentose or byssoid stroma, extending from or over the scale in many cases, but this is sometimes lacking. The synnemata (Plate III, fig. 8), in the North American and European forms, are usually small, either clavate, up to 0·6 mm. high and 0·25 mm. diameter, or conical, 0·5 mm. high, 0·25 mm. diameter, or, more generally, flattened pulvinate, up to 0·75 mm. long, 0·5 mm. broad. But

in tropical forms, they may attain a height of 2·5 mm. Both the stalked and sessile forms are usually clothed at the base with erect fascicles of hyphae arising from the basal stroma. The conidia are fusiform, straight, or straight with falcate tips, or slightly, but uniformly curved; they are up to eleven septate, but the septa are usually obscure, and frequently poorly developed, only two or three being present and those irregularly spaced; they measure 50–105 × 5–7 μ, as a rule, but sometimes are only 35 μ long. The short, curved, triseptate *Fusarium* conidium 18 × 4 μ, which is common in *Sphaerostilbe aurantiicola* (Plate V, fig. 11), has been observed in one American gathering.

The perithecia are crowded together on a well-developed stroma which often completely hides the scale insect (Plate III, fig. 7). They occur, in numbers up to about eighteen, in groups which may be a millimetre in diameter, and are usually at first partly covered by fascicles of hyphae arising from the stroma. When mature, they are bright orange red, darker round the ostiolum, glabrous, slightly rugose, opaque, globose, 0·3 mm. diameter, collapsing centrally as a rule; the ostiolum is minute, conical, acute, or scarcely evident. The cells of the perithecial wall are somewhat obscure, and the colour, by transmitted light, varies, according to the degree of maturity of the specimen, from yellow to red brown. The asci are cylindric, scarcely pedicellate, eight spored, spores obliquely uniseriate, 90–116 × 8–10 μ. Paraphyses are present, but diffluent. The ascospores are elliptic, ends obtuse, one-septate, not constricted, hyaline or yellowish, minutely verrucose, 12–19 × 5–8 μ.

The perithecial stage of this species was first collected by Ravenel in North America but the specimens were assigned by Berkeley to *Nectria muscivora* B. and Br. The latter species had been found at King's Cliffe, England, and had been described by Berkeley and Broome in Ann. Mag. Nat. Hist., Ser. 2, vol. VII, p. 188 (1851). It was parasitic on mosses. After their description, Berkeley and Broome added the note "We have this species from South Carolina on *Jungermanniae*." An examination of the type specimen of *Nectria muscivora* shows that it is not the same as Ravenel's species. *Nectria muscivora* has perithecia which have prominent papillaeform ostiola, and are embedded up to half their height, or up to the ostiolum, in a white floccose weft of mycelium; the perithecia are now amber coloured, the wall appearing hyaline by transmitted light; the ascospores are narrow oval to subfusoid, sometimes subcymbiform, with apices rounded or subacute, one-septate, rough, 15–24 × 6–8 μ; it is listed in Saccardo as *Calonectria*, but I was unable to find more than one septum in the spores of the specimen examined by me.

In 1854 (Ann. Mag. Nat. Hist., Ser. 2, vol. XIII, p. 461), Berkeley and Broome described a new species, *Atractium flammeum*. The type specimen was collected by J. Ralfs, on the bark of living willows, but the species was assigned to Berkeley and Ravenel, because it had been found "in similar situations, peeping up from beneath lichens," by Ravenel in South Carolina: it was described as "scarcely half a line high, cylindric, flame red, pruinose below, head convex, spores ·003 inch long, curved, fusiform, hyaline with six or more septa, seated on long sporophores." Berkeley and Broome added the note "Mr Ravenel in a late communication suspects it to be a state of some *Nectria*"; and on the herbarium specimens, Ravenel 1433 bears the note by Ravenel, "Can it be *Sphaeria muscivora* Berk.," while Ravenel 976 is marked by him "?*Sphaeria muscivora* Berk."

Ralfs's specimens in Herb. Kew, *ex* Herb. Berk. are "No. 90, *Atractium flammeum* Berk. and Rav., in Salix viva, Penzance," and "195, *Atractium flammeum* Berk. and Rav., in Fraxinum adhuc vivum, Penzance," with a drawing of the spore marked $\frac{1}{333}$. In Herb. B.M., *ex* Herb. Broome, there is a specimen from Ralfs, but it is marked "*Microcera coccophila* Desm., 468 *d*, on Willows, Penzance, January, J. Ralfs." None of these specimens is dated. In all the British specimens, the fungus is parasitic on *Chionaspis salicis*.

Of Ravenel's specimens, Herb. British Museum has, *ex* Herb. Ravenel, a specimen marked by Ravenel "*Atractium flammeum* Berk. and Rav. var. *minor*, S.C., Fasc. v, 80, Ravenel"; another with printed label, "86, *Atractium flammeum* Berk. and Rav. var. *minor*, ad corticem vivum Aceris"; "976, *Atractium flammeum* B. and R., Aest., ad Parmeliam, S.C., H.W.R."; "1433, *Atractium flammeum* B. and R., Feb., ad muscos, S.C., H.W.R."; "1843, *Atractium flammeum* B. and Rav., on *Acer rubrum*, S.C."; "1843, *Atractium flammeum* B. and Rav., on bark of living *Acer*, Aiken, S.C., H.W.R." Both 86 and 1843 contain perithecia.

In Herb. Kew, *ex* Herb. Berk., there are "(*Atractium flammeum* Berk. and Rav.), 976, *Sphaeria muscivora*? Berk. (in corticem non) on *Parmelia*, S.C., H.W.R.," the words in parentheses having been added by Berkeley; "(*Atractium flammeum* Berk. and Rav.), 1433, Feb., on mosses, *Frullania virginica*, S.C., H.W.R., Can it be *Sphaeria muscivora* Berk."; "1843, *Atractium flammeum* B. and R., on *Acer rubrum* (living trees), Aiken, S.C., H.W.R."; "No. 2958, *Stilbum*, Car. Inf."; and a packet, *ex* Herb. Cooke, bearing a label in Ravenel's handwriting "*Atractium flammeum* Berk. and Rav. var. *minor*."

All the foregoing specimens are the same, and are *Microcera*

coccophila Desm., while the perithecia are, as suggested by Ravenel, identical with the species referred by Berkeley to *Nectria muscivora* B. and Br. It may be noted that in Grevillea IV (1875), p. 47, Berkeley referred Ravenel 1843 to *Sphaerostilbe flammea* Tul., and, apparently, though the record is not clear, Nos. 976 and 1433, on *Parmelia* and *Frullania virginica*, to a "very distinct species on *Moquolia glauca*, Car. Inf. No. 5005 (*Atractium pallidum* B. and C.) which may possibly be the conidiiferous form of *Nectria muscivora*."

Berkeley sent specimens of *Atractium flammeum* to the Tulasnes, who described them as *Stilbum flammeum* in Acta hebdom. Acad. Sci. par., XLII, p. 704, and in Ann. Sci. Nat., Ser. IV, vol. V (1856), p. 114. They recorded the perithecial stage, but did not give the dimensions of the ascospore. In Selecta Carp. Fung. I, p. 130 (1861), they referred to it as *Sphaerostilbe flammea* (name only), while in vol. III, p. 104 of the same work (1865), they repeated their former description under the latter name. In the explanation of their plate, the Tulasnes stated that the description and figures were derived from an American specimen sent by Berkeley, though the fungus figured is said to be on "Saligni corticis frustrum," which is the supposed habitat of the European species. Their figure is not a good one, either of the perithecia or the conidial stage.

It is curious that the Tulasnes did not note that *Atractium flammeum* was identical with *Microcera coccophila* Desm. They did however state that *Microcera* did not differ from *Atractium* (Selecta Carp. Fung. I, p. 130). Specimens collected subsequently near Penzance were referred to *Microcera coccophila* by Broome, and later specimens from Ravenel bear the latter name.

Seaver's description of *Sphaerostilbe coccophila* (see p. 110) evidently refers to *Sphaerostilbe flammea*, and, of the specimens cited by him, Ellis, North American Fungi, No. 1333, and Ravenel, Fung. Car. Exsicc., No. 57, are *Sphaerostilbe flammea*. I have not seen Hume, Florida, No. 39.

Ellis and Everhart, North American Pyrenomycetes, p. 111, describe *Sphaerostilbe flammea* as having globose, bright red, nearly smooth perithecia crowded on or near the conidiophorous stroma; asci obovate oblong, eight-spored, sporidia ovate, obtuse, uniseptate, hyaline, slightly constricted, 12–16 × 5–6 μ; conidia 80–100 × 6·5, 6–9 septate. They cite the conidial fungus, Ravenel, Fung. Car. v. 86, which was issued as *Atractium flammeum* var. *minor*, and give the localities "on maple bark, Carolina (Ravenel)," and "on *Salix*, Louisiana, Langlois."

Seaver states that the ascospores of *Sphaerostilbe flammea* are elliptic to subfusoid, 15 × 6–7 μ. He cites the specimens Ellis

and Everhart, North American Fungi, 2nd Series, 3311; Langlois, 2290; Ellis, New Jersey; Dearness, Ontario, Canada.

Specimens which have been identified as *Sphaerostilbe flammea* Tul. are not numerous in British Herbaria, and many are incorrectly determined. Ellis and Everhart, North American Fungi, 2nd Series, No. 3311, *Sphaerostilbe flammea* Tul., and No. 3312, *Atractium flammeum* Berk. and Rav., are represented in Herb. B.M., but neither of these is correct. 3311 has densely clustered perithecia in cracks in the bark: the specimens are chiefly immature, and the available ascospores are narrow-oval or oblong-oval, 6–10 × 2–2·5. 3312 is a more immature gathering of the same species, and does not bear any *Atractium*.

Under *Sphaerostilbe flammea*, Herb. Kew has "Ravenel, Fung. Car. Exsicc., No. 5, 86," and "*Sphaerostilbe flammea* Tul., Rav. v, 86, sub *Atractium flammeum* v. *minor*, on *Acer*." The latter specimen is *ex* Herb. Cooke.

I have examined the following specimens of *Sphaerostilbe flammea* from Ravenel, which were referred to *Nectria muscivora*. Specimen *ex* Herb. Ravenel in Herb. B.M., marked "45, *Sphaeria muscivora* Berk., Nov., on *Jungermannia* growing on *Acer rub.*, S.C., H.W.R."; this has synnemata clavate, 0·5 mm. high, 0·05 mm. diameter below, expanding to 0·25 mm. above, or pulvinate, 0·5 × 0·25 mm.; conidia 60–80 × 5–6 μ, nearly straight, up to nine-septate, septa obscure and poorly developed, usually only three or four and irregularly distributed; conidia tend to collapse laterally; ascospores 12–19 × 6–8 μ. Specimen *ex* Herb. Ravenel in Herb. B.M., marked "45 *Sphaeria muscivora* Berk., Autumno, apud *Jungermannia*, S.C., H.W.R.," with drawing of ascospore marked "·0007 inch long"; apparently a duplicate of the former; both contain many synnemata but few perithecia. Specimen *ex* Herb. Ravenel in Herb. B.M., marked 1156 and spore measurement as above; this has caespitose collapsed perithecia. Ravenel, Fungi Car. Exsicc., No. 57, in Herb. Kew and Herb. B.M.; ascospores 13–17 × 6–8 μ. Specimens in Herb. Kew and Herb. B.M., *ex* Herb. Ravenel, "3263, *Nectria muscivora* Berk., on moss on *Acer*, St Johns (indecipherable), S.C., Apr. 81, H.W.R."; perithecia clustered in groups up to 1 mm. diameter, orange red, collapsing centrally, darker round the ostiolum, pruinose with white granules; ascospores 12–17 × 7–8 μ; synnemata flattened pulvinate up to 0·6 × 0·4 mm., or clavate, 0·6 mm. high, 0·25 mm. diameter; conidia nearly straight, 85–105 × 6 μ, up to eleven septate, septa obscure; conidia fairly abundant; the pulvinate synnemata bear numerous developing perithecia. Specimen in Herb. Kew, marked "*Nectria muscivora*, Car. Aust." which is apparently part of one of the Ravenel specimens with *Jungermannia*.

Specimen in Herb. Kew, marked "99, *Nectria muscivora*, on mossy trees, Apr., H.W.R., Houston, Texas."

The following Ravenel collections were correctly assigned to *Microcera coccophila*. Specimens in Herb. Kew and Herb. B.M., "Ravenel 2527, *Microcera coccophila* Desm., on living *Rhus*, Darien, Ga." Specimens in Herb. Kew and Herb. B.M., *ex* Herb. Ravenel, "3376, on exposed root of Water Oak, Darien, Ga., Nov. 81"; these appear to be the same gathering as "Ellis, N.A. Fungi, No. 1229, *Microcera coccophila* Desm., on bark of *Quercus* (? *palustris*), Darien, Ga., H. W. Ravenel," of which there is a specimen in Herb. B.M.; the sporodochia are pulvinate, oval or circular, up to 0·75 × 0·5 mm., sometimes confluent; conidia 75–80 × 5–6 μ, obscurely septate; a small curved *Fusarium* conidium, three septate, 18 × 4 μ, is present; some of these specimens bear clustered perithecia, with ascospores 14–17 × 6–7 μ.

Sphaerostilbe flammea was described as *Nectria laeticolor* by Berkeley and Curtis in Journ. Linn. Soc., x. (1868), p. 377, on specimens from Cuba, "on trees among hepatics." It is on a scale insect. Berkeley and Curtis cite the numbers 458, 542, 555. Specimen 458 is missing in Herb. Kew: the sheet is marked by Berkeley, "immature." 542 and 555 are *Sphaerostilbe flammea*, sometimes with perithecia on the synnemata. Specimens distributed as "765 Fungi Cubenses Wrightiani" are part of these gatherings. *Nectria laeticolor* is cited by Seaver as a synonym of *Sphaerostilbe flammea*. There is another Cuban specimen of *Sphaerostilbe flammea* among the unnamed *Dubiae* in Herb. Kew, apparently from Curtis.

Berkeley and Curtis subsequently, in Grevillea, IV, p. 45 (1875), described the same species as *Nectria aglaothele*, stating that it grew on the remains of a coccus. The type specimen of *Nectria aglaothele* in Herb. Kew is marked by Berkeley, "Sprague, on Alder, New England, No. 5378"; its ascospores are 13–17 × 6–8 μ. There are apparently duplicates of this collection in Herb. B.M. *ex* Herb. Bloxam, and in Herb. Kew *ex* Herb. Cooke and Herb. Currey, all marked by Berkeley "*Nectria muscivora* Berk., on alder, Mass." It would seem that Berkeley had discovered, after distributing the duplicates, that the American specimens which he had assigned to *Nectria muscivora* had been incorrectly determined.

In Grevillea, IV, p. 47 (1875), Berkeley recorded "*Sphaerostilbe coccophila* Tul., on *Alnus serratula*, Pennsylvania, Michener, No. 4316." The specimen in Herb. Kew is marked "4316, *Sphaerostilbe coccophila* Tul., *Atractium coccigena* B. and C., on *Alnus serratula*, Penn., Michener." It is *Microcera coccophila* Desm., the conidial stage of *Sphaerostilbe flammea*.

In 1882, Saccardo and Ellis (Michelia, II, p. 570) described this species as *Nectria subcoccinea* Sacc. and Ellis. Specimens were distributed by Ellis in North American Fungi, No. 1333, on bark of living alder, West Chester, Pa., October 1881, Everhart and Haines. In Ellis, 1333 in Herb. Kew and Herb. B.M., the perithecia are globose, clustered, with a minute conical ostiolum; the asci are 100–116 × 8 μ, cylindric, spores uniseriate or obliquely uniseriate; ascospores 13–18 × 6–7 μ; the synnemata are conical, 0·35 mm. high, 0·25 mm. diameter, clothed below with erect fascicles of hyphae, or pulvinate, 0·5 × 0·25 mm.; the conidia are nearly straight, or curved at one end, up to six septate, 35–45 × 5–6 μ. This example has unusually short conidia.

Ellis and Everhart, in North American Pyrenomycetes (1892), stated that *Nectria subcoccinea* Sacc. and Ellis was identical with the Ravenel specimens in Fungi Car. Exsicc., I, No. 57, which Berkeley had assigned to *Nectria muscivora*, and they drew up their description of the latter species from the specimens, Ellis, North American Fungi, No. 1333, which had been issued as *Nectria subcoccinea*. They noted that neither Ravenel's specimens nor Ellis 1333 showed anything of the white lanose patches mentioned in the original description of *Nectria muscivora*, but they nevertheless retained Berkeley's identification.

In Grevillea, IV, p. 45 (1875), Berkeley described a *Nectria* as *Nectria viticola* B. and C. This, according to von Höhnel and Weese in Herb. Kew, is *Nectria sanguinea*. It is not on a scale insect. But Passerini, in 1875, found a *Nectria* on *Vitis vinifera* in Liguria, which he referred, in Pirotta, Fung. Vit. VII, p. 45, to *Nectria viticola* B. and C. He sent specimens to Kew, labelled "*Nectria viticola* B. and C., Grevillea, Dec. 1875, nisi abstent conidia fusiformia, Ropallo, Liguria, ad sarmenta viva vitis vinifera, Iunio 75, G. Passerini." Cooke recognised that this was not the same as Berkeley and Curtis's species, and described it in Grevillea, XII, p. 81, as *Nectria Passeriniana* Cke. The specimen in Herb. Kew is marked by von Höhnel and Weese, "*Nectria viticola* Pass. = *Endothia* (?) *Passeriniana* (Cooke) Weese. *Hypocreopsis*??." This is a clustered *Nectria* with a well-developed stroma, covering a scale insect. Its ascospores are up to 18 × 8 μ. It has minute pulvinate synnemata and *Microcera* conidia. There is no doubt that this is *Sphaerostilbe flammea*.

A specimen from E. W. Berger, on scale of oak (*Chrysomphalus obscurus*), Florida, in Herb. British Museum, sent as *Sphaerostilbe coccophila* Tul., is *Sphaerostilbe flammea*. The ascospores are 13–18 × 7–8 μ; the synnemata are flattened pulvinate; the conidia are 75–80 × 5–6 μ, nearly straight, or

straight with falcate tips, up to nine-septate with well-defined septa.

Prof. C. Spegazzini has kindly forwarded me specimens of this species, on a scale insect on pine needles (locality?) January 20, 1916, and La Plata, May 19, 1919, under the MSS. name, *Nectria coccicida*. In these the synnemata may be clavate, up to 0·6 mm. high, 0·12 mm. diameter at the base, 0·25 mm. diameter above (Plate III, fig. 8), but the majority are conoid, up to 0·5 mm. high, 0·3 mm. diameter, or flattened pulvinate, up to 0·4 mm. long, 0·2 mm. broad, and 0·25 mm. high; they are situated on, or at the side of, the scale, and usually arise from a well-developed stroma; the conidia are straight, or straight with falcate tips, or uniformly curved, pale yellow under a low magnification, hyaline when more highly magnified, up to nine-septate, ends obtuse, 80–88 × 6–7 μ. The asci measure 90–110 × 9–10 μ, and the ascospores, 13–17 × 6–8 μ.

Microcera coccophila Desm., "No. 1350, Plantes Cryptogames de France, Ed. II, Ser. 1, 1836–51," specimen in Herb. B.M., has synnemata flattened pulvinate or discoid, with a rather broad whitish margin, up to 0·6 mm. diameter, or conical, up to 0·6 mm. high, 0·3 mm. diameter below, or clavate, with erect fascicles of hyphae at the base; the sheath divides above into separate hyphae; the conidia are scanty, 50–80 × 5–6 μ, almost straight, fusoid, with obscure septa up to nine. This specimen also bears clustered perithecia on a well-developed stroma; the developing perithecia are orange, covered with fascicles of hyphae from the stroma; the mature perithecia are red; the ascospores are 12–18 × 5–7 μ.

Both Herb. B.M. and Herb. Kew have *Microcera coccophila* Desm., "No. 1750, Plantes Cryptogames de France, Ed. 1, Ser. 1, 1825–51"; this has some of the synnemata cylindric, up to 0·7 mm. high, 0·2 mm. diameter.

Conidial specimens from Penzance, the type locality of *Atractium flammeum* Berk. and Rav., when collected in later years, were referred correctly to *Microcera coccophila* Desm. In Herb. B.M., there are specimens *ex* Herb. Broome, *Microcera coccophila* Desm. (1) Trengwainton, Penzance, 14 Dec. 1869; (2) nr. Penzance, Dec. 1869; (3) Trengwainton, 4 Dec. 1869, marked "early stage of *Nectria Ralfsii*?." It is not related to *Nectria Ralfsii*. Specimen 1 shows the developing perithecia of *Sphaerostilbe flammea*. Herb. B.M. also has Cooke 350 and 534, and duplicates from Herb. Cooke.

Herb. Kew has, under *Microcera coccophila* Desm., a specimen *ex* Herb. Berkeley, marked "Penzance, C.E.B., Dec. 1869," containing minute synnemata on a well-developed stroma; Cooke, Fungi Brit. Exsicc., No. 350 (two examples); Cooke, Fungi

Brit. Exsicc., Ed. II, No. 534, C. E. Broome (two examples); and duplicates *ex* Herb. Cooke. Cooke's specimens are generally poor; some are not localised or dated; others are marked, "near Penzance, 14 December, 1869," "Penzance, Dec. 1869, C. E. Broome," and "Cornwall, Jan. 1870, C. E. Broome," respectively.

In the cover of *Myriangium Duriaei* in Herb. B.M., there is an undated specimen, marked "near Ryde, Isle of Wight, A.B." In addition to the *Myriangium*, this bears *Microcera coccophila*.

A specimen, *ex* Herb. Cooke, under *Microcera coccophila* Desm. in Herb. Kew, is marked "*Atractium coccigena* B. and C., Cort. Persicae, Ludoviciana." There is very little left of the fungus, but it is apparently *Microcera coccophila*. I am indebted to Mr Grove for the suggestion that the locality is Louisiana.

Of the specimens cited by Ellis and Everhart in "North American Pyrenomycetes" as *Sphaerostilbe coccophila* Tul., that on *Alnus serratula* from Pennsylvania is, as already stated, *Sphaerostilbe flammea*, while Ravenel, Fungi Americani, No. 286 is *Sphaerostilbe aurantiicola*.

Microcera pluriseptata Cke. and Massee was described in Grevillea, XVII, p. 43, as occurring on *Calocera* and bark, in Mexico. The type specimen in Herb. Kew was originally endorsed by Berkeley "Brazil, Cordova, Salle," but Cooke crossed out Brazil and substituted Mexico. The fungus is on a scale insect, and the supposed *Calocera* consists of the almost effete synnemata, which are up to 2·5 mm. high. The conidia are 75–90 × 5–7 μ, five- to seven-septate, but with somewhat obscure septa; they tend to collapse laterally. Perithecia occur on the scale insects and on the old synnemata; they are typical *Sphaerostilbe flammea*, with ascospores 13–17 × 7 μ, oval, pale yellow. *Microcera pluriseptata* Cke. and Massee is consequently a synonym of *Microcera coccophila* Desm.

Fusarium coccinellum (Kalch.) Thuem., *Fusisporium coccinellum* Kalch., was described by Kalchbrenner in Fungi Austro-Africani, Flora, LIX (1876), p. 426, and issued by de Thümen, Mycotheca Universalis, No. 782, the specimens being from the Cape of Good Hope. It is on a scale insect. In the specimens, Thuemen 782, in Herb. Kew and Herb. B.M., the synnemata are clavate, 1·25 mm. high, 0·25 mm. diameter below, expanding to 0·5 mm. diameter above, or shortly stalked, with flattened globose heads up to 0·75 mm. diameter, or sessile and pulvinate. The conidia are 74–80 × 5–6 μ, almost straight, or straight with falcate tips, or slightly curved, obscurely septate, with up to nine septa. As noted by Kalchbrenner, the base of some of the sessile forms swells strongly in water. The specimens were

collected by P. MacOwan at Somerset East, on *Acacia horrida*, the collection number being 1059. There is a part of this collection in Herb. Kew, "Kalchbrenner No. 1059, on *Acacia horrida*, Cape," determined by Cooke as *Sphaerostilbe flammea conidiophora*, while another part, also in Herb. Kew, is labelled in an unknown handwriting, "*Sphaerostilbe flammea* Tul., Cap. b. sp., leg. MacOwan, No. 1059, comm. $\frac{9}{83}$. Type of Kalchbrenner." Herb. Kew has also a specimen, *ex* Herb. MacOwan, marked "1064, *Nectria haematococca* B. and Br., ad corticem *Acaciae horridae*" which was also referred to *Sphaerostilbe flammea* by Cooke; it is the same as the other specimens and does not contain perithecia. No perithecia have been observed in this gathering, but it appears to be *Microcera coccophila* rather than *Microcera aurantiicola*.

In Herb. Kew, there are specimens, *sub Microcera coccophila*, from New Zealand—Rev. W. Colenso, B. 82, on bark of *Alectryon excelsum*; Colenso, B. 919; and Colenso, B. 727. These are large forms, with synnemata up to 2·25 mm. high, 0·6 mm. diameter. The conidia are 75–85 × 6 μ, straight with acute tips, or straight with slightly falcate tips, or slightly uniformly curved, up to nine-septate, with well-developed septa. No perithecia have been observed, but from the shape of the conidia, the specimens would appear to have been referred correctly to *Microcera coccophila*.

Herb. B.M. has the Australian specimen from Bailey, *ex* Herb. Broome, referred to by McAlpine under *Microcera coccophila*. It is marked, Brisbane, F. M. Bailey, No. 383, and contains well-developed synnemata on a scale insect on leaves and stem of Citrus. The conidia are 75–100 × 6 μ, up to nine-septate, with well-developed septa; some have falcate tips, but the majority are fusoid and straight. It would appear to be correctly named.

Sphaerostilbe aurantiicola (B. and Br.) Petch.

This species was described by Berkeley and Broome, as *Nectria aurantiicola*, in Fungi of Ceylon, No. 1028, their description being—"Peritheciis aurantiacis in stromate erecto sitis; ascis clavatis; sporidiis ellipticis uniseptatis, sporisque fusuloideis (No. 190). On orange twigs. Sporidia 15 μ long, 7·5 μ wide; spores fusiform, curved, multiseptate, 92 μ long; others triseptate and strongly curved, 20 μ long. Apparently growing from some Coccus."

The type specimen in Herb. Kew, *ex* Herb. Berkeley, is now very poor. Better specimens are to be found in Herb. British Museum, *ex* Herb. Broome. The following description has been drawn up from Ceylon specimens which agree with the types.

The synnemata arise from a narrow, yellowish-white, loose weft of hyphae at one side of, or surrounding, the scale. They are orange-red, or pinkish-red with a blood-red head, generally erect, clavate, expanding into an ovoid head (Plate III, fig. 1), or with a cylindrical stalk and a subglobose head, or uniformly cylindric. Small specimens are about 0·8 mm. high, 0·15 mm. diameter below, expanding into a head, 0·3 mm. diameter, but they may attain a height of 2 mm., with a stalk 0·4 mm. diameter and a head 0·6 mm. diameter. Several may arise from the same scale, and adjacent synnemata may fuse laterally into a broad band. The stalk is sometimes smooth, but more usually longitudinally fibrillose, especially at the base. When fresh, the fructification is subtranslucent: when dry, it is hard and horny, and, while the smaller specimens may retain the blood-red colour of the head, the larger become a nondescript brownish red or reddish yellow. Some specimens are almost sessile, clavate or ovoid. The head is often laterally compressed, and often hooked or produced laterally into a point.

The outer layer of the stalk hyphae forms a continuous sheath which divides above into long triangular teeth, about 120 μ long and 16 μ broad at the base. In small specimens, these teeth may converge at the apex of the head, but in the larger they are adherent to its sides. The outer sheath hyphae are about 4 μ diameter, equal, septate, and united by ladder connections. The interior stalk hyphae are continued above as branched conidiophores, 3 μ diameter, with long branches. Ladder connections are common between the bases of the conidiophores.

The conidia are cylindric, tapering towards the ends (Plate V, fig. 10), or long fusoid, straight, or slightly curved at the ends, hyaline, multiseptate. Under a low power they have a distinct yellow tinge. Up to eleven septa have been counted, but nine is more usual. The two ends of the spore are not equally curved; the distal end is slightly and uniformly curved and terminates in an obtuse point, while the proximal end is more falcately curved and more acute. A few uniformly curved conidia, of the same length, may sometimes be found. Measurements of the conidia from different gatherings are 88–110 × 6–7 μ; 90–116 × 6–7 μ; 80–112 × 6–7 μ; 84–104 × 7 μ; 96–120 × 5–6 μ; 90–120 × 6–7 μ; 70–92 × 5–6 μ.

In addition to the conidia described above, a smaller, more curved conidium (Plate V, fig. 11) is found in some gatherings. It was noted by Berkeley and Broome, and has been observed in five recent collections, including one from Dominica. It does not occur in the head with the long conidia, but on the looser mycelium at the base of the stalk. Sometimes it is found at the base of the perithecium, although there may be no conidial

fructification evident there under a magnification of forty diameters. This conidium is strongly curved, up to two-thirds of a circle, fusoid, hyaline, one- to three-septate, with obtuse tips, 12–16 × 4 μ, measured from tip to tip, not round the curve.

The perithecia (Plate III, fig. 3) are situated round the scale, scattered or clustered, with no evident stroma, but usually attached by a few inconspicuous radiating hyphae. As a rule, they occur round scales which do not bear the conidial synnemata. But, as noted by Berkeley and Broome, perithecia also occur at the base of the synnemata, or along their stalks, or even among the conidiophores in the head. This however only occurs on the larger synnemata, and even on those it is not the rule. I have only one collection in which this occurs, and in that the perithecia on the synnemata are immature. Parkin illustrates this position of the perithecia in his figure 9.

The perithecia are smooth, or pruinose with a few yellow granules, subsequently becoming smooth, very minutely rugose when highly magnified, 0·2–0·25 mm. diameter, subglobose, with a broad papillate ostiolum, or subconoid, scarcely papillate (Plate III, fig. 4). They are usually orange-red, becoming blood-red or dark red, and subtranslucent, but immature examples may be orange-yellow. The latter may account for Berkeley and Broome's "aurantiacis," but it is more probable that they gave the colour of the wall by transmitted light. In old examples, the wall, when mounted, is red-brown, but younger examples show an orange-yellow wall, though viewed as opaque objects they are orange-red. This is a common phenomenon in red Nectrias in the tropics. The cells of the perithecium wall are thick-walled and up to 12 μ diameter, though the structure is usually obscure. The ostiolum is fimbriate.

The asci are cylindrico-clavate, scarcely pedicellate, eight-spored, with diffluent paraphyses with granular contents. The spores may be uniseriate, or obliquely uniseriate, or obliquely uniseriate above and uniseriate below. The dimensions of the asci in different gatherings are 72–80 × 6–7 μ; 70–80 × 7 μ; 70–88 × 6 μ; 66–74 × 7–9 μ; 70–90 × 7–8 μ; 74–80 × 7 μ; 70–80 × 7–8 μ.

The ascospores are oval, or broadly oval, ends obtuse, hyaline, becoming yellowish, wall rather thick and minutely warted, one-septate, not constricted at the septum, except slightly in old extruded spores. Their dimensions in different collections are, 9–12 × 5–6 μ; 10–12 × 4–5 μ; 11–13 × 5 μ; 9–13 × 5–6 μ; 11–13 × 5–6 μ; 10–14 × 5–6 μ; 10–14 × 4–6 μ.

I have the following recent collections of this species. On *Diaspis pentagona* on *Flacourtia Ramontchi*, Ceylon. On *Aspidiotus aurantii* on Rose, Ceylon. On *Aspidiotus aurantii* on

Citrus, Ceylon. On *Aspidiotus aurantii* on Mulberry, Ceylon (five collections). On *Aspidiotus* sp. on *Cycas*, Ceylon. On a diaspid (?) on *Thespesia*, Ceylon. On *Mytilaspis citricola* on *Citrus*, Ceylon (three collections). On ? *Porococcus*, on Palmyra, Ceylon. On *Lepidosaphes* sp. on Pepper (*Piper nigrum*), South India (C. A. Barber, 1905). On *Lepidosaphes* sp. on *Citrus*, Madagascar. Conidial stage on *Aspidiotus* and *Lepidosaphes*, and perithecial stage on *Lepidosaphes*, on *Citrus*, Dominica.

In the specimen from Dominica, the synnemata are small, and the conidia measure only 70–92 × 5–6 μ: most of them are three-septate, a few five-septate. The asci are 74–80 × 7 μ, and the ascospores 10–14 × 4–6 μ. The perithecia are identical with the Ceylon form of *Nectria aurantiicola*, and the small, curved *Fusarium* spores occurred with them.

A *Sphaerostilbe*, parasitic on scale insects in Japan and Formosa, has been recorded, with some doubt, by Miyabe and Sawada, as *Sphaerostilbe coccophila* Tul. I have been able to examine the following specimens, *ex* Herb. Sapporo.

On a scale on apple trees, Tsukisappu near Sapporo, October 5, 1907. In this, some synnemata are suberect, with a short stout stalk, 0·2 mm. diameter and 0·4 mm. high, expanding into an ovoid head, 0·3 mm. diameter, and 0·4 mm. high, pointed above; the stalk in these is dark red, subtranslucent, and the head pale yellowish, the latter colour being due to the disappearance of most of the conidia. Other synnemata are almost sessile, ovoid, or sometimes merely pulvinate, dark red. The sheath divides above into teeth, but the teeth break up above into separate hyphae, as a rule, as long as, or longer than, the conidiophores. The conidia measure 84–100 × 5–7 μ, and are up to nine-septate, nearly straight or curved at the tips, one end more obtuse than the other. When examined under a low power the conidia are distinctly yellowish.

In another gathering, on a coccid on *Ficus Wightiana*, Sozan, Formosa, May 1911, the synnemata are mostly stalked, but the heads have been eaten off by insects.

In a collection, on coccids on *Citrus nobilis*, Shimpo, Formosa, May 7, 1910, the synnemata are generally small, pulvinate, blood-red masses at the side of the scale, sometimes several confluent and forming a fringe at one end.

Similar synnemata occur on scale insects on *Citrus nobilis*, Taihoku, Formosa, April 25, 1911. Some of the sessile pulvinate synnemata are up to 0·4 mm. long and 0·2 mm. broad. Stalked forms, with stalks up to 0·3 mm. high and 0·2 mm. diameter, also occur in this gathering. The conidia are 80–96 × 6–7 μ.

Perithecia appear to be rare in the Formosan collections. Miyabe and Sawada state that they have only found them once,

on Tea, Taihoku, Sozan, May 1911. I have seen a leaf of that gathering, which bore one perithecium, not quite mature. It was subconoid, 0·15 mm. diameter, orange-red, slightly pruinose with yellow granules, seated on the scale without any evident stroma. No mature asci were found, but two loose ascospores were observed, measuring $10\times3\,\mu$ and $12\times5\,\mu$ respectively; Miyabe and Sawada state that the ascospores measure $8–10\times4–5\,\mu$.

On the available specimens, the Japanese and Formosan forms would appear to be referable to *Sphaerostilbe aurantiicola*.

In Herb. British Museum, there are the following specimens from Florida, communicated by E. W. Berger;—(1) on *Aspidiotus perniciosus*, San José Scale, on Peach, all conidial; (2) on *Chrysomphalus aonidium*, Florida Red Scale of Citrus, on *Citrus*, two conidial specimens; (3) on *Lepidosaphes beckii*, Purple Scale of Citrus, one specimen containing the conidial stage and scattered perithecia with ascospores $10–13\times5–6\,\mu$.

As pointed out under *Sphaerostilbe coccophila*, the specimens collected at Florence in 1860, which furnished the perithecial examples of that species are *Sphaerostilbe aurantiicola*. These are represented in British herbaria by the following.

"No. 262, Rabenhorst, Fungi Europaei Exsicc., Ed. nov., Ser. secunda. *Nectria episphaeria* Tode. Ad *Lauri* corticem in horto Boboli Florentiae, Majo 1860, leg. L. Caldesi." Specimens in Herb. Kew and Herb. B.M. The bark is densely covered with scale insects. The perithecia are usually scattered without evident stroma, sometimes clustered, orange-red becoming dark red, conoid, usually collapsing laterally; apex darker, conical, or papillate; asci $65–75\times7\,\mu$; ascospores $9–14\times4–5\,\mu$; perithecial wall red-brown by transmitted light. Small curved triseptate spore rather common, $14–18\times3–3{\cdot}5\,\mu$. Synnemata appear to be absent.

"No. 269, Rabenhorst, Fungi Europaei Exsicc., Ed. nov., Ser. secunda. *Microcera coccophila* Desm. Florence, ad corticem *Lauri* in horto Boboli dicta, Majo 1860, leg. L. Caldesi." Specimens in Herb. Kew and Herb. B.M. A poor development on scattered scale insects. Synnemata pulvinate; conidia $75–85\times6\,\mu$, few in comparison with the number of conidiophores; septa up to nine, but usually few and obscure. Perithecia immature, orange-red, subtranslucent, scattered or in small clusters, wall yellow when mounted.

"No. 543, Erbar. Crittogam. Ital., *Microceras coccophila* Desm., Sull' Alloro nel giardino di Boboli a Firenze, Aprile 1860, Caldesi." Specimen in Herb. B.M.; resembles Rabenhorst 262, and Erbar. Crittogam. Ital. 539; contains chiefly developing *Nectria*. Synnemata flattened pulvinate, circular, 0·4 mm. diameter, or clavate, 0·75 mm. high, 0·25 mm. diameter; conidia scanty,

80 × 6 μ, almost straight with one end falcate, or slightly curved.

"No. 539, Erbar. Crittogam. Ital., *Nectria episphaeria* Fr., Sull' Alloro nel giardino di Boboli a Firenze, Maggio 1860, Caldesi." Specimen in Herb. B.M. ? same collection as Rabenhorst 262. Apparently no synnemata. Small curved *Fusarium* spore present, 18 × 3·5 μ. Perithecial wall red-brown when mounted; ascospores 10–12 × 4 μ.

The foregoing are apparently all parts of the same growth of the fungus. Another collection was made in the same locality six years later, "No. 542, Erbar. Crittogam. Ital., Ser. II, *Sphaerostilbe coccophila* Tul., Sull' Alloro nel giardino di Boboli a Firenze, 1866, Caldesi," of which there is a specimen in Herb. B.M. A narrow, yellowish byssoid stroma surrounds the scale. The synnemata are flattened pulvinate, up to 0·6 mm. long, 0·4 mm. broad, and 0·2–0·3 mm. thick, flesh-coloured, with a narrow white or yellowish tomentose margin, or erect, subcylindric or clavate, up to 0·75 mm. high, 0·3 mm. diameter; few conidia are present, and these are found among the conidiophores; the conidia are nearly straight with slightly falcate tips, 60–75 × 5–6 μ, up to seven-septate, with obscure septa: some conidia are strongly guttulate. On one effete cylindric synnema, the sheath persisted as a hyaline membrane. The immature perithecia are orange-red, mature perithecia red; they are situated in small groups on the marginal stroma, or sometimes on the synnemata; the ascospores are 9–12 × 4–5, a few 14–15 × 6 μ. The short curved *Fusarium* spore is present.

In Herb. Kew and Herb. B.M., there are American specimens *ex* Herb. Ravenel, under *Microcera coccophila*, "No. 2512, in corticis Mori, Darien, Georgia." This gathering appears to be the same as "No. 286, H. W. Ravenel, Fungi Amer. Exsicc., *Microcera coccophila* Desm. in corticis *Mori*, Darien, Georgia," of which there is a specimen in Herb. B.M. The synnemata are clavate, up to 1 mm. high, 0·4 mm. diameter, or flattened pulvinate, up to 1 mm. long and 0·6 mm. broad; the conidia are 56–80 × 5–6 μ, obscurely septate, with a few irregularly-arranged septa. The small curved *Fusarium* spore, 18 × 3 μ, is present. The ascospores are 9–12 × 4–5 μ. This specimen is *Sphaerostilbe aurantiicola*.

Sphaerostilbe coccidophthora (Zimm.) Petch.

This species was described by Zimmermann, as *Nectria coccidophthora*, from specimens on *Lepidosaphes* sp. on *Coffee arabica*, and on *Parlatoria zizyphi* on *Citrus*, found at Buitenzorg, Java. The following are the main details of his description.

The conidial fructification was scarlet (mennig-rot), shortly stalked, and swelled considerably in water. The stalk was 0·3–0·4 mm. long, and the head, 0·4–0·45 mm. long. The

conidia were surrounded by hairs, which were united laterally by ladder connections and converged above. The conidia were hyaline, cylindric, slightly curved at the tips, six- to eight-septate, 110–120 × 6 μ.

The perithecia were clustered at the base of the conidial fructification, or scattered over the stroma which permeates the insect. They were globose, carmine-red, with a papillate, somewhat paler ostiolum, 280 μ high and 230 μ diameter. The asci were eight-spored, 100 μ long. The spores were one-septate, hyaline, obtuse, not constricted, 17–20 × 7–8 μ.

Zimmermann compared his species to *Nectria aurantiicola* B. and Br., from which he decided it differed in the colour of the perithecia, and the form of the conidial fructification, according to the figures given by Berkeley and Broome. His figure of the conidia shows spores of the *Microcera* type, not *Pseudomicrocera*.

The only other record of this species appears to be that of Parkin, who assigned all the Ceylon *Microcera* forms to *Nectria coccidophthora*. Parkin's measurements of asci and ascospores appear to be from specimens of *Nectria coccidophthora*, but his figures of synnemata and conidia (9, 10, 11) are *Nectria aurantiicola*. Of Parkin's specimens which are now available, that on *Chionaspis biclavis* on *Tabernaemontana* is *Nectria coccidophthora*, and probably that on *Asterolecanium miliaris* on Bamboo, while, from his description, that on *Chionaspis biclavis* on Tea was the same species.

I have collections of what appears to be undoubtedly this species, on *Chionaspis biclavis* on Tea, Ceylon (two gatherings), on *Chionaspis* on an undetermined host plant, Ceylon (two gatherings), on *Chionaspis biclavis* on *Tabernaemontana*, Ceylon (Parkin's specimen), on *Chionaspis*, on an undetermined host plant, India (E. J. Butler), and on *Diaspis pentagona* on *Flacourtia*, Seychelles. It is noteworthy that, of the seven collections six are on *Chionaspis*.

The synnemata arise from a narrow, yellowish-white, loose, floccose stroma, or weft of hyphae, round the scale. They are orange-red or scarlet, paler towards the base, generally erect, usually clavate, expanding into an ovoid head. As a rule, they are not as stout as those of *Nectria aurantiicola*, being commonly about 0·8 mm. high, with a stalk 0·15 mm. diameter, and a head 0·3 mm. diameter, but sometimes examples occur which attain a height of 1·4 mm., and a stalk diameter of 0·25 mm. The stalk is generally longitudinally fibrillose. When fresh, the synnemata are subtranslucent, and become hard and horny when dry. Specimens in which the stalk is almost wanting are not uncommon; these may be ovoid, or conical, about 0·4 mm. high, and 0·25 mm. diameter. As in *Nectria aurantiicola*, the head is often curved to one side. The structure of the synne-

mata is identical with that of *Nectria aurantiicola*. The small, curved, *Fusarium* spores which occur in the latter have not been observed in *Nectria coccidophthora*, nor have developing perithecia been observed on its stalk above the base.

The conidia are cylindric, or long fusoid, almost straight, slightly curved at the ends, hyaline, multiseptate. Up to eleven septa have been counted, but the most common numbers are six to nine. In the usual gathering, however, large numbers of immature, unseptate conidia are met with. In shape, they agree with those of *Sphaerostilbe aurantiicola*, but the tips are sometimes slightly more curved. Septation begins at the distal end, and it is not uncommon to find conidia which have developed two or three consecutive septa at that end, before any are visible elsewhere. Measurements of the conidia from the different collections gave the following dimensions: 76–93 × 6 μ; one 62 × 6 μ; 78–96 × 6–7 μ; 88–98 × 6 μ; 88–106 × 6–7 μ; the total variation is 62–106 × 6–7 μ. The conidia agree in shape with Zimmermann's figure, but I have not met with any 110–120 μ long. In the available collections, the conidia of *Sphaerostilbe aurantiicola* usually attain a greater maximum length than those of this species.

The perithecia may be scattered, or clustered in groups up to ten. They are sometimes situated at the bases of the synnemata, but in general they are found on scales which do not bear any conidial fructification. They may be seated on a narrow floccose stroma round the scale, or the stroma may completely cover the scale, and the perithecia may be scattered over it. On the other hand, they may arise at the margin of the scale without any visible stroma.

The perithecia are subglobose or subconoid, 0·2–0·3 mm. diameter, collapsing laterally, orange-red at first, becoming blood-red, subtranslucent, covered with minute yellow, or yellowish-red, granules except round the ostiolum (Plate III, fig. 6). Weathered specimens lose the granular covering, and are blood-red to dark red, but when magnified the area round the ostiolum is evidently smoother than the rest of the wall. The shape of the ostiolum is highly variable: as a rule, it is slightly papillate, with a flat papilla about 60 μ diameter, but in some specimens the apex is merely obtusely conical. In one gathering, on *Chionaspis*, a few of the perithecia have the ostiolum produced and cylindrical, up to 96 μ high and 106 μ diameter, but in other examples on the one scale they are simply slightly papillate. This variation makes it impossible to separate the scale insect Sphaerostilbes on the shape of the ostiolum. The wall, viewed by transmitted light, is orange-yellow in immature, or young, examples, but red-brown in old specimens. The structure is generally obscure, but in some cases thick-walled

cells, up to 10 μ diameter can be recognised. The wall bears projecting cells, or one-septate processes, sometimes growing from the cells of the wall, and sometimes appearing to be merely fastened to it by a yellow substance. The ostiolum is fimbriate. When detached, the perithecium usually has a minute, and somewhat compact, mass of mycelium at the base.

The asci are cylindrico-clavate, i.e. cylindric, slightly attenuated below, and usually shortly pedicellate. They are accompanied by long, linear paraphyses, which disappear before the asci are mature; the paraphyses have granular contents. The asci are eight-spored, and the spores slightly obliquely uniseriate. Measurements of the asci from different collections gave 105–115 × 9–10 μ; 100–106 × 10 μ; 100–110 × 10 μ; 116–136 × 10 μ; 84–102 × 8 μ.

The ascospores are oval, or broadly oval, one-septate, thick-walled, ends obtuse, hyaline, becoming yellowish, not constricted at the septum, wall minutely warted, 13–22 × 7–9 μ. Measurements from different gatherings are 17–20 × 8–9 μ, one 14 × 6 μ, another 16 × 5 μ (old spores; asci not present); 14–20 × 7–9 μ, a few 17–18 × 6 μ; 13–16 × 8–9 μ, with some, in the ascus, globose, continuous, thick-walled, 9–10 μ diameter; 13–18 × 7–9 μ, one 16 × 5 μ; 16–22 × 8–9 μ. The specimen on *Chionaspis biclavis* on *Tabernaemontana* has spores 14–17 × 6–7 μ, in asci 84–102 × 8 μ, but in all other respects it does not differ from the other gatherings.

Parkin recorded a *Nectria* on *Asterolecanium miliaris* on Bamboo which he considered different from *Nectria coccidophthora*. The available perithecia on this specimen are immature, but they resemble those of *Nectria coccidophthora*, in being covered with yellow granules. From one old weathered perithecium, however, spores, some of them germinating, were obtained, which measured 21–27 × 9–10 μ. They are oval, somewhat attenuated towards one end, slightly constricted, pale yellow, thick-walled, with the wall minutely warted. Parkin describes them as elliptical and somewhat pointed, 22–27 × 9–10 μ, and the ascus as 115 × 13·5 μ. He also records that the conidia, which are not now present, measured 100–110 × 5·5–7·5 μ. The constriction of the ascospores may be disregarded, as extruded *Nectria* spores frequently swell, so that they become constricted at the septum, but the dimensions of the spores are greater than anything observed in *Nectria coccidophthora*. The specimen, however, is not now in good condition, and, provisionally, I would refer it to *Nectria coccidophthora* on the general characters of the perithecium.

(To be continued in next part.)

Published the 15th July, 1921.